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IN
COTTON WEAVING

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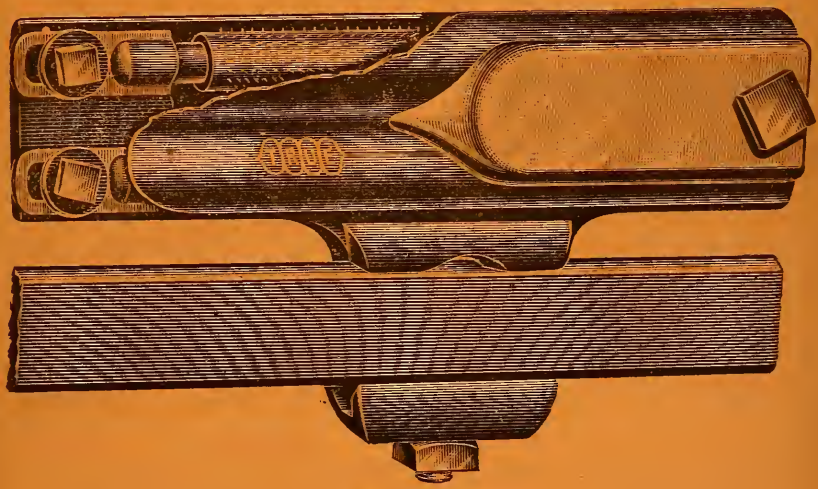

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CALCULATIONS

IN

COTTON WEAVING

With Worked Examination Papers and the Uniform Price Lists of Plain, Fancy, and Coloured Goods.

BY

JAMES HOLMES, Mem. Soc. Arts,

Author of "Cotton Cloth Designing," "Slide Rules for Textiles," &c.

(First Honours Cotton Manufacture City and Guilds of London Institutes; Lecturer in Weaving at the Burnley, Nelson, and Accrington Technical Schools).

FOURTH EDITION.

Burnley:

LUPTON BROS., 38 & 40, MANCHESTER ROAD.

—

1903.

Lyud. P. Ward.
194 Lyndhurst Grove Lane
Shacklehill Burnley.

PRINTED BY

JOHN DIXON, LTD., VICTORIA STREET,

BURNLEY.

NB 402

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PREFACE TO THE SECOND EDITION.

The success which has attended the First Edition of this book leads me to think that it must have been of some service to the student and the trade with which it deals. The present Edition has been carefully revised, and much additional matter added, especially under the head of heald and reed calculations; this part of the subject seems to be little understood, and the questions given at recent examinations gives me an opportunity of working out the examples in full. The answers to the examination questions are of much value, as they are generally of a practical kind, and no definite rule could be laid down for working them.

JAMES HOLMES.

Burnley Technical School,
October 26th, 1897.

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FOURTH EDITION.

This Edition has undergone considerable revision. The Uniform Price Lists have now been put at the end, for easier reference, and all the alterations have been embodied in the list. The worked examination papers are continued to date.

J. H.

Burnley Technical School,
August 21st, 1903.

PREFACE TO FIRST EDITION.

The object of the present work is to supply a book which can be used with equal advantage in the work-shop or the school. The examples are worked out in full, so as to be easily understood by elementary students, and the unusual and novel method adopted in giving the rules will enable advanced students to solve any problem which may be placed before them.

That the subject is one which at the present time is attracting the attention of educational bodies leaves no manner of doubt. The Board Schools, in their continuation classes, give it a prominent place; the Lancashire and Cheshire Institutes hold a special examination in "Cotton Weaving Calculations"; and the questions given at the City and Guilds of London Institutes examinations in "Cotton Weaving" are many of them calculation questions.

J. H.

Burnley, *January 24th, 1896.*

CONTENTS.

PAGE.

CHAPTER I.

YARN AND CLOTH CALCULATIONS 9

Yarn Tables—Wrapping Yarn – To Find Counts or Weight of a Short Length—Wrapping Table—Folded Yarn—To Find Weight, Counts, Ends, or Length of any Quantity of Yarn—Back Beam Table—Weight of Warp and Weft in a Piece—Cost of a Piece—Diameters of Yarns.

CHAPTER II.

HEALDS AND REEDS 31

CHAPTER III.

LOOM CALCULATIONS 36

Taking-up Motions—Old Motion—Pickles' Motion—Strain on Yarn due to Dwell on the Tappet—Strain on the Yarn in Shedding—Speed of Looms—Shafting, Gearing, and Tappets—Carrier Wheels—Intermediate Wheels - Speed of Tappets—Levers—Size of Shed and Stroke of Tappet.

CHAPTER IV.

SLASHER AND BEAMING CALCULATIONS 58

Slasher Measuring and Marking Motion—Preparing a Set of Slashers Beams—Weight of Size on Yarn—Beaming Frame.

CHAPTER V.

EXAMINATION QUESTIONS AND ANSWERS 66

Taken from City and Guilds of London Examination Papers (1890 to 1903)—Lancashire and Cheshire Examination Papers, Calculations only (1894 to 1897)

CHAPTER VI.

WAGES 200

Uniform List—Satins, Drills, Drillettes List—Dobby List—Dhooties – Coloured Goods—Working List—Beaming List—Winding List—Jacquard List—Overlookers' List.

INDEX.

PAGE

Average counts 91, 139

Back beam tables .. 18, 102, 126, 145

Beaming calculations .. 64

Beaming frame calculation..... 112

Beaming list 236

Carrier wheels..... 46

Changing from one pattern to another.... 85, 133

Check pattern, give weight and hanks..... 102

City and Guilds of London examination papers 66, 199

Colne coloured list.. 226, 235

Coloured yarn, weight of 70, 191

Counts of weft, to find in a piece 116

Cost of piece.. 24, 88, 89, 96, 98, 115, 128, 150, 154, 155, 157, 161, 162, 164, 167, 168, 175, 178, 182, 184, 186, 193, 197

Diameters of yarn .. 28, 137, 140, 159, 164, 177

Dwell on the tappet 41

Examination questions.. 66 to 199

Folded yarn 13

Folded yarn, cost of, 14, 79, 97, 125, 151

Force of beat up..... 41

Formula for levers..... 52

Formula for slasher 58

Formula for speeds 43

PAGE

Formula for speed of tappets 47

Formula for taking-up motion.....36, 37

Formula for warp and weft 22

Formula for weight and counts 17

Formula for wrapping .. 10

Heald calculation 31, 130, 141, 147, 192

Healds and reeds 31

Heald stripe calculation 141

Intermediate wheels 50, 77, 115

Labour cost 153, 160, 167, 170, 172, 181

Lancashire and Cheshire examination papers 98, 124, 138

Length of warp, to find 81, 139

Levers 51

Lift of tappet 53, 78, 132

Loom calculations 36

Overlookers' poundage .. 236

Percentages..... 63

Percentage of size..... 86

Percentage of size in a piece.....91, 127, 133, 136

Pickles' taking-up motion 40

Prices paid for weaving.. 26

Proportionate values of warp and weft in a piece.....92, 195

Reed calculation.... 113, 138

Reeds and Healds 31

Reeds, Stockport and Bolton counts..107, 138, 173

PAGE

Relative diameters of yarns 29, 73, 137
Resultant counts 13
Sateen, price of a piece.. 73
Set of beams 62
Shedding, strain on the yarn 41
Shirting, price of a piece 81
Side tappets..... 49
Size in a piece 91, 136
Size of loom pulley .. 43, 109
Size of shed 53
Size on yarn.....63, 98, 140
Slasher calculation 58, 106, 143
Speed of looms..... 43, 176
Speed of tappets..... 46
Stocks and bowls 76
Standing charges.... 95, 150
Strain on yarn due to dwell 41, 79
Strain on yarn due to shedding.....42, 72
Stroke of tappet 53
Table for back beams .. 18
Table of decimal parts of a yard 27
Table wrapping 12
Tables, yarn..... 9
Taking-up motions 36, 68, 83, 100, 126, 154
Tappets, side 49
Tappets, underneath 47
Tappets, speed of 46
Three-fold yarn 15, 79, 125, 145
Time to weave a piece .. 77
Top levers, length of.. 56, 84
Twist, to find weight.. 17, 75

PAGE

Two-fold yarn 13, 66, 127, 192
Uniform list 200
Value of a piece 24
Value of decimal parts of a lb. 28
Wage list 200
Warp, weight in a piece 21
Warper's beams, value of a set 112
Warper's calculation 109, 126, 132, 190
Weaving prices..26, 332, 333, 334
Weaving price for colored goods 235
Weaving price for plain.. 233
Weaving price for sateen 234
Weft, value in a piece.. 23, 75
Weight of beams..... 18
Weight of one lea of yarn 10
Weight of yarn, to find 17, 174
Wheels and drums from engine to loom 69, 144
Wheels, speed of..... 46
Winding list..... 236
Wrapping table 12
Wrapping yarns..9, 153, 160, 166, 172
Yarns, counts of..... 17
Yarns, diameters 28
Yarns, folded 13
Yarns, on back beams .. 20
Yarns, short lengths 11
Yarns, tables 9
Yarns, weight of one lea 10
Yarns, wrapping..9, 153, 160, 166, 172, 181, 196

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CALCULATIONS

IN

COTTON WEAVING.

CHAPTER I.

YARN AND CLOTH CALCULATIONS.

Yarn Tables.

WEIGHTS.

	24	grains	= 1 dwt.
	437½	„	= 1 oz.
16 oz. or	7000	„	= 1 lb.

LENGTHS.

	1½ yards	=	cir. of wrap reel.
	120 „	=	1 lea.
7 leas or	840 „	=	1 hank.

The number of hanks in a lb. weight of any yarn gives the counts.

Wrapping Yarns.

Wrap 120 yards (1 lea), divide the weight in grains into 1000.

Example—120 yards of yarn weighs 25 grains; what is the counts?—1000 ÷ 25 = 40's count.

It is usual to wrap 4 cops 1 lea from each, and divide the total weight into 4000.

Example—4 leas of yarn weighs 100 grains; what is the counts?—$4000 \div 100 = 40$'s counts.

To find the weight in grains of 1 lea of any counts, divide 1000 by the counts.

Example—What is the weight in grains of 1 lea of 40's?—$1000 \div 40\text{'s} = 25$ grains.

To find the counts of a short length of yarn.—

Multiply 7000 by the length in yards and divide by 840 times weight in grains.

Example—12 yards of yarn weighs 2 grains; what is the counts?—$7000 \times 12 = 84000 \div 840 \times 2 = 84000 \div 1680 = 50$'s counts.

The following methods will be found very useful:—

To find the weight or counts of 1 lea of yarn—

Counts
Weight in grains } multiplied together

equals 1000.

If counts is required, divide 1000 by the weight.

Example—What is the counts of a lea of yarn, the weight of which is 50 grains?

$$1000 \div 50 = 20\text{'s}.$$

If the weight is required, divide 1000 by the counts.

Example—What is the weight in grains of 1 lea of 20's yarn?—$1000 \div 20 = 50$ grains.

To find the weight, length, or counts of a short length of yarn :—

$$\left.\begin{matrix} 7000 \\ \text{Length in yards} \end{matrix}\right\} \text{multiplied together}$$

equals

$$\left.\begin{matrix} 840 \\ \text{Weight in grains} \\ \text{Counts} \end{matrix}\right\} \text{multiplied together.}$$

If one of the factors is missing, divide by that group to which it belongs.

Example—$7\frac{1}{2}$ yards of yarn weighs $2\frac{1}{2}$ grains, what is the counts?

$$7000 \times 7\tfrac{1}{2} \div 840 \times 2\tfrac{1}{2} = 25\text{'s counts.}$$

Example—What is the weight of $7\frac{1}{2}$ yards of 25's yarn?

$$7000 \times 7\tfrac{1}{2} \div 840 \times 25 = 2\tfrac{1}{2} \text{ grains.}$$

Example—What length of yarn is there in $2\frac{1}{2}$ grains of 25's?

$$840 \times 25 \times 2\tfrac{1}{2} \div 7000 = 7\tfrac{1}{2} \text{ yards.}$$

Examples—The weight of the wrapping from 4 cops is 130 grains, 120 yards from each; what is the counts?

$$4000 \div 130 = 30{\cdot}77\text{'s counts.}$$

What is the weight of 2 leas of 50's yarn?

$1000 \div 50 = 20$ grains weight of 1 lea. $20 \times 2 = 40$ grains weight of 2 leas.

What is the counts of $2\frac{1}{2}$ yards of yarn the weight of which is $1\frac{1}{2}$ grains?

$$7000 \times 2\tfrac{1}{2} \div 840 \times 1\tfrac{1}{2} = 13{\cdot}9\text{'s counts (nearly).}$$

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Wrapping Table.

Showing the weight in grains of 4 leas of yarn from 20's to 80.

Grains.	Counts.	Grains.	Counts.	Grains.	Counts.	Grains.	Counts.
50	80·0	88	45·5	126	31·7	164	24·4
51	78·4	89	45·0	127	31·5	165	24·2
52	77·0	90	44·5	128	31·2	166	24·1
53	75·5	91	44·0	129	31·0	167	24·0
54	74·0	92	43·5	130	30·7	168	23·8
55	72·7	93	43·0	131	30·5	169	23·7
56	71·4	94	42·6	132	30·2	170	23·5
57	70·0	95	42·1	133	30·0	171	23·4
58	69·0	96	41·7	134	29·9	172	23·3
59	67·8	97	41·2	135	29·6	173	23·1
60	66·7	98	40·8	136	29·4	174	23·0
61	65·6	99	40·4	137	29·2	175	22·9
62	64·5	100	40·0	138	29·0	176	22·7
63	63·5	101	39·6	139	28·8	177	22·6
64	62·5	102	39·2	140	28·6	178	22·5
65	61·5	103	38·8	141	28·4	179	22·3
66	60·6	104	38·5	142	28·2	180	22·2
67	59·7	105	38·1	143	28·0	181	22·1
68	58·8	106	37·7	144	27·8	182	22·0
69	58·0	107	37·4	145	27·6	183	21·9
70	57·1	108	37·0	146	27·4	184	21·8
71	56·4	109	36·7	147	27·2	185	21·7
72	55·6	110	36·4	148	27·0	186	21·5
73	54·8	111	36·0	149	26·8	187	21·4
74	54·0	112	35·7	150	26·7	188	21·3
75	53·4	113	35·4	151	26·5	189	21·2
76	52·6	114	35·0	152	26·3	190	21·1
77	52·0	115	34·8	153	26·1	191	20·9
78	51·3	116	34·5	154	26·0	192	20·8
79	50·6	117	34·1	155	25·8	193	20·7
80	50·0	118	33·9	156	25·6	194	20·6
81	49·4	119	33·6	157	25·5	195	20·5
82	48·8	120	33·3	158	25·3	196	20·4
83	48·2	121	33·0	159	25·2	197	20·3
84	47·6	122	32·8	160	25·0	198	20·2
85	47·0	123	32·5	161	24·8	199	20·1
86	46·5	124	32·2	162	24·7	200	20·0
87	46·0	125	32·0	163	24·5		

Folded Yarns.

If two or more counts are twisted together, to find the resultant counts.—

Find the weight of 1 lea of each, then divide the total weight into 1000.

Example—What is the resultant counts of twisting 25's and 100's together?—$1000 \div 25\text{'s} = 40$ grains. $1000 \div 100 = 10$ grains. $40 + 10 = 50$ grains total weight. Therefore $1000 \div 50 = 20$'s counts.

If one counts is given, to find another to be twisted with it to get another counts—Find the weight of a lea of each, the difference between the two weights divided into 1000 will give the counts required.

Example—What must be twisted with 25's to produce 20's?—$1000 \div 25 = 40$ grains. $1000 \div 20 = 50$ grains. $50 - 40 = 10$ grains difference. Therefore $1000 \div 10 =$ 100 counts.

What will be the resultant counts of 10's and 20's twisted together?

$$\frac{1000}{10} = \text{Grs. } 100$$

$$\frac{1000}{20} = 50$$

$$150 \;)\; 1000 \;(\; 6{\cdot}6\text{'s counts.}$$

$$\begin{array}{r} 900 \\ \hline 1000 \\ 900 \\ \hline 100 \end{array}$$

What counts must be twisted with 20's so that the resultant counts will equal 10's?

$$\frac{1000}{10} = \text{Grs. } 100$$

$$\frac{1000}{20} = 50$$

$$50 \;)\; 1000 \;(\; 20\text{'s counts.}$$

$$\begin{array}{r} 100 \\ \hline 0 \end{array}$$

What will be resultant counts of 10's, 15's, and 20's twisted together?

$$\frac{1000}{10} = \text{Grs. } 100$$

$$\frac{1000}{15} = 66{\cdot}6$$

$$\frac{1000}{20} = 50{\cdot}$$

216·6) 10000 (4·61's counts.

8664

13360

12996

3640

2166

474

Cost of Folded Yarn.

When yarns of different prices per lb. are twisted together, to find the cost.

To find the cost of 2-fold.

Example—After twisting 20's and 40's together, what is the price per lb. of the folded yarn—20's cost 6d per lb., 40's 8d per lb., allow 1d per lb. for doubling?

Multiply counts 20 by the price of 40's

Multiply counts 40 by the price of 20's.

Thus— 20's at 8d = 160

40's at 6d = 240

60 400

Add counts together; add prices together; then divide the sum of the prices by the sum of the counts—

60) 400 (6·66 price per lb. With 1d per lb. added for doubling = 7·66 or $7\frac{2}{3}$

360

400

360

40

To find the cost of 3-fold yarn.—

Example—What is the price per lb. of the folded yarn obtained from twisting 10's at 6d per lb., 30's at 8d per lb., and 40's at 9d together?

Find the resultant counts of 10's and 30's.

$1000 \div 10\text{'s} = 100$ grains. $1000 \div 30\text{'s} = 33{\cdot}3$. Total weight, 133·3 grains.

$1000 \div 133{\cdot}3$ grains $= 7{\cdot}5$ counts.

The price per lb. of 7·5 counts is—

10's at 8d =	80
30's at 6d =	180
40	260

$260 \div 40 = 6\frac{1}{2}$d per lb.

The price of 40's is 9d per lb.; the price of 7·5's is $6\frac{1}{2}$d; find the cost of these two twisted together.

40's at $6\frac{1}{2}$d =	260
7·5's at 9d =	$67\frac{1}{2}$
47·5	$327\frac{1}{2}$

$327\frac{1}{2} \div 47{\cdot}5 = 6{\cdot}9$d, nearly price per lb. of the 3-fold yarn.

To find the cost per lb. of 4-fold yarn.—

Example—What is the price per lb. of a yarn obtained from twisting together 40's at 6d per lb., 60's at 8d per lb., 80's at 10d per lb., 100's at 12d per lb.?

Find (first) the resultant counts of 40's and 60's and the price per lb. of the 2-fold yarn, thus—

Grs.

$\frac{1000}{40} = 25$

$\frac{1000}{60} = 16{\cdot}6$

41·6

1,000 ÷ 41·6 grains = 24's counts.

The price per lb. of 40's and 60's, which when twisted together equals 24's, is—

40's at 8d =	320
60's at 6d =	360
100	680

680 ÷ 100 = 6·8d price of 24's counts.

(Second) Find the resultant counts of 80's and 100's and the price per lb. of the folded yarn, thus—

$\frac{1000}{80}$ Grs. $= 12{\cdot}5$

1000 ÷ 22·5 grains = 44·4's counts.

$\frac{1000}{100} = \frac{10}{22{\cdot}5}$

The price per lb. of 80's and 100's, which when twisted together equals 44·4's, is—

80's at 12d =	960
100's at 10d =	1000
180	1960

1960 ÷ 180 = 10·88d, price of 44·4's counts 2-fold.

(Third) The price per lb. of 24's folded yarn is 6·8d; the price per lb. of 44·4's folded yarn is 10·88d. What is the price per lb. of the two combined?

24's at 10·88d =	261·
44·4's at 6·8d =	301·9
68·4	562·9

562·9 ÷ 68·4 = 8·2d price per lb. of the 4-fold yarn.

To find the weight, counts, length, or number of ends in any quantity of yarn.—

$$\left.\begin{matrix}\text{Ends.}\\ \text{Length in yards.}\end{matrix}\right\} \text{multiplied together.}$$

equals

$$\left.\begin{matrix}840\\ \text{Weight in lbs.}\\ \text{Counts.}\end{matrix}\right\} \text{multiplied together.}$$

If one of the factors is missing, divide by that group to which it belongs.

A few examples are given to illustrate the method of working :—

To find the weight—Multiply the total number of ends by the length in yards, and divide by 840 times counts.

Example—What is the weight of 420 ends, 1000 yards long, 50's counts?—$420 \times 1000 \div 840 \times 50\text{'s} =$ 10 lb. weight.

To find the counts—Multiply the total number of ends by the length in yards, and divide by 840 times weight.

Example—What is the counts of 420 ends, 10 lbs. weight, 1000 yards in length?—$420 \times 1000 \div 840 \times 10 =$ 50's counts of yarn.

To find the length—Multiply 840, counts, and weight together, and divide by the number of ends.

Example—What is the length of a warp weighing 10 lb., 50's yarn, and containing 420 ends?—$840 \times 50 \times 10 \div 420 = 1000$ yards.

To find the ends—Multiply 840, counts, and weight together, and divide by the length in yards.

Example—A warp 1000 yards long, 50's yarn, weighs 10 lb., how many ends does it contain? $840 \times 50 \times 10 \div 1000 = 420$ ends.

Example—What is the weight of a set of slashers beams, which consists of five beams of 400 ends each, length 17500 yards, counts 42's?

$$\frac{5 \times 400 \times 17500}{840 \times 42} = 992 \text{ lb. } 1 \text{ oz. weight}$$

The weight of yarn on back beams can easily be obtained from a reference to the following table :—

Counts.	Length.	Ends.											Weight of 10 ends.
		360	370	380	390	400	410	420	430	440	450	460	
20	15,000	321·4	330·3	339·2	348·1	357·1	366·	374·9	383·9	392·8	401·7	410·7	8·928
22	"	292·2	300·3	308·4	316·5	324·6	332·7	340·9	349·	357·1	365·2	373·3	8·117
24	"	267·8	275·3	282·7	290·1	297·6	305·1	312·5	320·	327·4	334·8	342·2	7·44
26	"	247·3	354·1	261·	267·9	274·7	281·6	288·5	295·3	302·2	309·1	316·	6·868
28	"	229·6	236·	242·3	248·7	255·1	261·5	267·9	274·2	280·6	287·	293·4	6·377
30	"	214·3	220·2	226·2	232·1	238·1	244·	250·	256·	261·9	267·9	273·8	5·952
26	17,500	288·5	296·5	304·5	312·5	320·5	328·5	336·5	344·5	352·5	360·6	368·6	8·013
28	"	267·8	275·3	282·7	290·2	297·6	305·1	312·5	319·9	327·4	334·8	342·3	7·44
30	"	250·	256·9	263·8	270·8	277·8	284·7	291·7	298·6	305·6	312·5	319·4	6·944
32	"	234·4	240·9	247·4	253·9	260·4	266·9	273·4	280·	286·5	293·	299·5	6·51
34	"	220·6	226·7	232·8	238·9	245·1	251·2	257·4	263·5	269·6	275·7	281·9	6·127
36	"	208·3	214·1	219·9	225·7	231·5	237·3	243·	248·8	254·6	260·4	266·2	5·787
38	"	197·4	202·9	208·4	213·9	219·3	224·8	230·3	235·7	241·2	246·7	252·2	5·482
40	"	187·5	192·7	197·9	203·1	208·3	213·5	218·7	224·	229·2	234·4	239·6	5·208
42	"	178·5	183·5	188·5	193·4	198·4	203·4	208·3	213·3	218·2	223·2	228·2	4·96

Counts.	Length.	Ends.											Weight of 10 ends.
		360	370	380	390	400	410	420	430	440	450	460	
44	17,500	170·4	175·1	179·9	184·6	189·4	194·1	198·8	203·6	208·3	213·	217·8	4·734
46	"	163·	167·6	172·1	176·7	181·2	185·7	190·3	194·8	199·3	203·8	208·3	4·53
48	"	156·2	160·6	164·9	169·3	173·6	177·9	182·3	186·6	191·	195·3	199·6	4·34
50	"	150·	154·1	158·3	162·5	166·6	170·8	174·9	179·1	183·3	187·5	191·6	4·166
52	"	144·2	148·2	152·2	156·2	160·2	164·2	168·2	172·2	176·3	180·3	184·3	4·006
54	"	138·9	142·7	146·6	150·5	154·3	158·2	162·	165·9	169·7	173·6	177·5	3·858
56	"	133·9	137·6	141·4	145·1	148·8	152·5	156·2	159·9	163·7	167·4	171·1	3·72
58	"	129·3	132·9	136·5	140·1	143·7	147·3	150·8	154·4	158·	161·6	165·2	3·592
60	"	125·	128·5	131·9	135·4	138·8	142·3	145·8	149·3	152·7	156·2	159·7	3·47
62	"	120·9	124·3	127·7	131·	134·4	137·7	141·1	144·5	147·8	151·2	154·5	3·36
64	"	117·2	120·4	123·7	126·9	130·2	133·4	136·7	140·	143·2	146·5	149·7	3·255
66	"	113·6	116·7	119·9	123·1	126·2	129·4	132·5	135·7	138·9	142·	145·2	3·156
68	"	110·3	113·4	116·4	119·5	122·5	125·6	128·7	131·7	134·8	137·9	140·9	3·064
70	"	107·1	110·1	113·1	116·1	119·	122·	125·	128·	130·9	133·9	136·9	2·976
72	"	104·1	107·	109·9	112·8	115·7	118·6	121·5	124·4	127·3	130·2	133·1	2·893
74	"	101·3	104·1	107·	109·8	112·6	115·4	118·2	121·	123·9	126·7	129·5	2·815
76	"	98·7	101·4	104·1	106·9	109·6	112·4	115·1	117·8	120·6	123·4	126·1	2·741
78	"	96·1	98·8	101·4	104·1	106·8	109·5	112·1	114·8	117·5	120·1	122·8	2·67
80	"	93·7	96·3	99·	101·5	104·2	106·7	109·4	112·	114·6	117·2	119·8	2·604

Yarn on back beams.—

The length of yarn on a back beam is generally five wraps of 3500 yards each—$3500 \times 5 = 17500$ yards. A short method of finding the weight of any number of ends this length is shown below.

Add three ciphers to the number of ends and divide by 48 times counts.

This is obtained from the formula—

$$\frac{\text{Ends} \times \text{length}}{840 \times \text{counts}} = \text{weight.}$$

therefore

$$\frac{840 \times 1000}{17500} = 48.$$

This 48 is a number which when multiplied by the counts, and divided into the number of ends with three ciphers added, gives the weight.

Example—What is the weight of yarn on a back beam of 360 ends, 17500 yards long, 30's yarn?

Usual method—

$$\frac{360 \times 17500}{840 \times 30} = 250 \text{ lb.}$$

Short method—

$$\frac{360000}{48 \times 30} = 250 \text{ lb.}$$

The following table gives the divisors to be used for different counts:—

Counts.	Divisor.	Counts.	Divisor.	Counts.	Divisor.
20's	960	30's	1440	40's	1920
22's	1056	32's	1536	42's	2016
24's	1152	34's	1632	44's	2112
26's	1248	36's	1728	46's	2208
28's	1344	38's	1824	48's	2304

The table can be extended by multiplying 48 by the counts.

Example—$48 \times 20 = 960$ divisor for 20's.

In using these divisors three ciphers must be added to the number of ends.

If the length is five wraps of 3000 yards each—$3000 \times 5 = 15000$ yards, deduct $\frac{1}{7}$ from the results.

Example—What is the weight of four beams, each containing 410 ends and 15000 yards 34's yarn?

The weight for 17500 yards is—

$$\frac{1640000}{1632} = 1004{\cdot}8 \text{ lb. weight for 17500 yards.}$$

$$\text{Less } \tfrac{1}{7}\text{th} = 1004{\cdot}8 \div 7 = 143{\cdot}5.$$

Therefore $1004{\cdot}8 - 143{\cdot}5 = 861{\cdot}3$ lb. weight for 15000 yards.

To find the weight of warp and weft in a piece of cloth.—

The following percentages must be allowed for:—

Burnley Printers and other cloths of a similar kind—Add 6 per cent. to width of cloth to get the width in the reed; deduct 6 per cent. from the threads per inch, to find the reed used; add 6 per cent. to find the tapers length. This last percentage will cover $36\frac{1}{2}$ inches to the yard (long stick).

To find the ends in the warp, multiply the width in the reed by the reed used, or multiply the threads per inch by the width of the cloth.

To find the weight of warp, multiply the ends in the warp by the tapers length and divide by 840 times counts.

To find the weight of weft, multiply the width in the reed, picks per inch, and cloth length together, and divide by 840 times counts.

In the following example the threads per inch and the width of cloth are taken to find the ends.

Find the weight of warp and weft in a piece made to

the following particulars, width of cloth 32 inches, length 100 yards, 60 threads per inch, 84 picks per inch, 40's warp, 68's weft. Allow 5 per cent. for contraction in length; 6 per cent. contraction in width.

Warp—

32 width of cloth.
60 threads per inch.
1920 ends in warp.
105 tapers length
840 9600
40 19200
33600) 201600 (6 lbs. weight.
201600

Weft—

34 in. nearly, width in reed.
84 picks per inch.
840 136
68 272
6720 2856
5040 100 cloth length.
57120) 285600 (5 lb. weight.
285600

The following methods show how to obtain the width of cloth, ends per inch, ends in the warp, tapers length, counts, or weight of warp yarn in a piece :—

Width of cloth
Threads per inch } multiplied together.
Tapers length

equals

840
Counts } multiplied together.
Weight

If one of the factors is missing divide by that group to which it belongs.

Taking the same example as in the previous case, 32-inch cloth, 100 yards cloth length, 60 threads per inch, 84 picks per inch 40's warp, 68's weft. Allow 5 per cent. for length ; 6 per cent. for width.

Find the weight of warp—

100 yards + 5 per cent. = 105 yards tapers length.

$$\frac{32 \times 60 \times 105}{840 \times 40} = 6 \text{ lb. weight of warp.}$$

Find the counts of warp—

$$\frac{32 \times 60 \times 105}{840 \times 6} = 40\text{'s counts of warp.}$$

Find the threads per inch in the cloth—

$$\frac{840 \times 40 \times 6}{32 \times 105} = 60 \text{ threads per inch.}$$

Find the width of the cloth—

$$\frac{840 \times 40 \times 6}{60 \times 105} = 32 \text{ in. width of cloth.}$$

Find the tapers length—

$$\frac{840 \times 40 \times 6}{32 \times 60} = 105 \text{ yards tapers length.}$$

Find the total number of ends used in the warp—

$$\frac{840 \times 40 \times 6}{105} = 1920 \text{ ends.}$$

To find the width in the reed, picks per inch, cloth length, counts, or weight of weft in a piece of cloth.—

Width of the cloth in the reed
Picks per inch
Cloth length
} multiplied together

equals

840
Counts
Weight
} multiplied together

If one of the factors is missing divide by that group to which it belongs.

Taking the same example as in the previous case, 32 inches cloth or 34 inches in the reed, 100 yards cloth length, 60 threads per inch, 84 picks per inch, 40's warp, 68's weft.

Find the weight of weft—

$$\frac{34 \times 84 \times 100}{840 \times 68} = 5 \text{ lb. weight of weft.}$$

Find the counts of weft—

$$\frac{34 \times 84 \times 100}{840 \times 5} = 68\text{'s counts of weft.}$$

Find the picks per inch—

$$\frac{840 \times 68 \times 5}{34 \times 100} = 84 \text{ picks per inch.}$$

Find the width in the reed—

$$\frac{840 \times 68 \times 5}{84 \times 100} = 34 \text{ in. width in the reed.}$$

Find the cloth length—

$$\frac{840 \times 68 \times 5}{84 \times 34} = 100 \text{ yards cloth length.}$$

To find the cost of a piece of cloth made to the following particulars :—

32/120 16 × 16 32's/ woven in a 36 in. reed
/ l.s. 60 / 40's space loom.

Fully stated—32 inches width of cloth, length 120 yards long stick (36½ inches to the yard), 16 threads per quarter inch, 16 picks per quarter inch, 32's twist, 40's weft, twist 8d per lb., weft 8d per lb., weaving to find, expenses half weaving. Add 6 per cent. to 32 to obtain the width in the reed. $32 \times 6 = 192 \div 100 = 1{\cdot}92$. Therefore width in the reed $= 32 + 1{\cdot}92 = 33{\cdot}92$ inches.

Deduct 6 per cent. from 64 threads per inch to find

the reed used—$64 \times 6 = 384 \div 100 = 3{\cdot}84$ (nearly 4). Therefore reed used $= 64 - 4 = 60$ reed.

Add 6 per cent. to 120 to find the tapers length—$120 \times 6 = 720 \div 100 = 7{\cdot}2$. Therefore $120 + 7{\cdot}2 = 127{\cdot}2$ yards tapers length.

Weight of Yarn.

Warp—

33·92 width in reed.
60 reed.
2035·20 ends.
127·2 tapers length.
4070
14245
4070
2035
258852·0 (9·63 (nearly), or 9 lb. 10 oz.
241920 weight of warp.
169320
161280
80400
80640

Weft—

33·92 width in reed.
64 picks per inch.
13568
20352
2170·88
120 cloth length.
4341760
217088
260505·60 (7·75 weight of weft.
235200
253056
235200
178560
168000
10560

840
32
1680
2520
26880)

840
40
33600)

It is usual to add 4 per cent. to weight of weft to allow for waste: Therefore $7{\cdot}75 \times 4 \div 100 = {\cdot}31$. Therefore $7{\cdot}75 + {\cdot}31 = 8{\cdot}06$, or 8 lb. 1 oz. weight of weft.

Price Paid for Weaving.

In working out the weaving price the items are taken in the order they occur in the piece, namely—

Width of loom.
Width of cloth.
Length.
Reed.
Pick.
Twist.
Weft.
10 per cent. off list.

Thus—

2d price per pick.
·22 = 11 per cent. off for width of loom.
1·78
122 = length in yards, 36 in. to the yard.
356
356
178
2·1716
16 actual picks.
130296
21716
34·7456
3·4745 = 10 per cent. off list price.
31·2711

Price, 2/7¼.

Cost of piece—

Warp, 9 lb. 10 oz. at 8d per lb.,	-	6s 5d.
Weft, 8 lb. 1 oz. at 8d per lb.,	-	5 $4\frac{1}{2}$
Weaving, - - - -	-	2 $7\frac{1}{4}$
Expenses half weaving,	- -	1 $3\frac{1}{2}$
Total cost,	- -	15s $8\frac{1}{4}$d.

Decimal Parts of a Yard Expressed in Inches.

This is useful for converting the decimal parts of a yard into inches, after adding the percentage to the cloth length to find the tapers length.

Example—A piece of cloth is 120 yards long, the tapers length is 6 per cent. more: Find it? $120 \times 6 = 720 \div 100 = 7{\cdot}20$. 6 per cent. of $120 = 7{\cdot}2$, added to $120 = 127{\cdot}20$. Referring to the table, $\cdot 19 = 7$ inches; therefore $\cdot 20 = 7\frac{1}{2}$ inches. Tapers length is 127 yards $7\frac{1}{2}$ inches.

Table Showing Inches Expressed in Decimal Parts of a Yard.

Inches.		Inches.		Inches.	
1	·03	13	·36	25	·70
2	·06	14	·39	26	·72
3	·08	15	·42	27	·75
4	·11	16	·44	28	·78
5	·14	17	·47	29	·81
6	·17	18	·50	30	·83
7	·19	19	·53	31	·86
8	·22	20	·56	32	·89
9	·25	21	·59	33	·92
10	·28	22	·61	34	·94
11	·31	23	·64	35	·97
12	·33	24	·67	36	1·00

It need only be remembered that ·03 equals about one

inch; for practical purposes it is quite near enough, and the table can be used for reference.

Below is given a table showing the value in ounces of the decimal parts of a pound, useful in converting the weights of warp and weft, when worked to decimal places, to their equivalents in ounces.

Example—A piece weighs 10·88 lb. Referring to the table, ·88 = 14 oz., therefore weight of piece 10 lb. 14 oz.

·06 = 1 oz.	·31 = 5 oz.	·56 = 9 oz.	·81 = 13 oz.
·13 = 2 oz.	·38 = 6 oz.	·63 = 10 oz.	·88 = 14 oz.
·19 = 3 oz.	·44 = 7 oz.	·69 = 11 oz.	·94 = 15 oz.
·25 = 4 oz.	·50 = 8 oz.	·75 = 12 oz.	1·00 = 16 oz.

It will be useful to remember that ·06 equals about 1 oz.

Diameters of Yarns.

To find the diameter of a thread of any counts of yarn, extract the square root of the number of yards in a pound weight, and deduct 10 per cent.

Example—What is the diameter of a thread of 46's yarn; number of yards in a lb. = 840 × 46 = 38640 yards? Extract the square root.

```
                38640 ( 196·5   Nearly 196·6
                1
              -------
1 × 2 = 29  ) 286
                261
              -------
19 × 2 = 386 ) 2540
                 2316
               -------
196 × 2 = 3925 ) 22400
                 19625
               --------
                  2775
```

Therefore 196·6 less 10 per cent.

10 per cent = 19·6

177·0 = diameter of 46's, or 177 threads side by side will stand on one inch of space; and to

produce a perfect plain cloth with 46's warp and 46's weft, 88½ threads and picks per inch will be required. This is obtained by multiplying the diameter by the ends in the pattern, and dividing by the ends, plus intersections. Below is given a section of plain cloth, the circles = ends, the interlacing line the weft.

Fig. 1.

2 ends in the pattern, and 2 intersections. Therefore $177 \times 2 \div 4 = 88\frac{1}{2}$ ends and picks required.

The number of threads and picks per inch in plain cloth equals half the diameter of the yarn used.

Diameter of yarns vary as the square root of the counts.—The diameter of 36's = 157. The diameter of 16's = $104\frac{1}{2}$.

Example—The diameter of 36's is 157; what is the diameter of 16's? It will be thicker on account of being coarser. Square root of 36 = 6. Square root of 16 = 4; therefore $157 \times 4 \div 6 = 104\frac{1}{2}$, diameter of 16's.

The diameter of 36's = 157. Threads and picks per inch required in plain cloth = $78\frac{1}{2}$.

The diameter of 16's = $104\frac{1}{2}$. Threads and picks per inch required in plain cloth = $52\frac{1}{4}$.

In changing from one counts to another, to find the ends and picks required.—Multiply threads per inch in given cloth by the square root of the counts of the required cloth, and divide by the square root of the counts of the given cloth.

Example—A piece of cloth is made with $78\frac{1}{2}$ threads per inch, 36's yarn; it is changed to 16's yarn; what number of threads per inch will be required? Square

root of 36's = 6. Square root of 16's = 4. Therefore $78\frac{1}{2} \times 4 \div 6 = 52\frac{1}{4}$ threads per inch required.

To find the counts, in changing from one number of threads per inch to another number of threads per inch.—Multiply the threads in the required cloth by the square root of the counts of the given cloth, and divide by the threads in the given cloth, square the result for the answer.

Example—What counts must be used in changing from $78\frac{1}{2}$ threads per inch, 36's yarn, to $52\frac{1}{4}$ threads per inch? Square root of 36 = 6. Therefore $52\frac{1}{4} \times 6 \div 78\frac{1}{2} = 4$, and 4 squared = 16's counts.

In changing from one pattern to another, to find the ends and picks per inch to use.—Carry both patterns out until they repeat on the same number of ends. Multiply the threads per inch in the given cloth by the ends, plus intersections, in the given pattern, and divide by the ends, plus intersections, in the pattern of the required cloth.

Example—A plain cloth is made with $88\frac{1}{2}$ threads per inch; it is changed to a 4-end twill, two up, two down; how many threads and picks will be required.

FIG. 2.

Given cloth 4 ends plus 4 intersections = 8.

Required cloth 4 ends plus 2 intersections = 6.

Therefore $88\frac{1}{2} \times 8 \div 6 = 118$ threads and picks per inch required.

CHAPTER II.

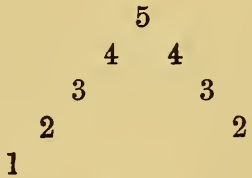
HEALDS AND REEDS.

Counts of Healds and Reeds.

The Stockport counts of healds and reeds is now almost universal. It is based on the number of dents in the reed on the space of 2 inches; and, as the ends in plain cloth are dented two ends in a dent, it means that a 60 reed will give 60 threads per inch in the loom.

Four healds make a set, so that for a 60 reed four healds will be used, with 15 stitches per inch knit on each stave.

If a 60 reed is used in a 5 end sateen with 5 staves, there will be 12 stitches per inch knit on each stave; or the counts of the healds will be equal to $4 \times 12 = 48$'s. If the ends are drawn in, point draft thus, using a 64 reed:—



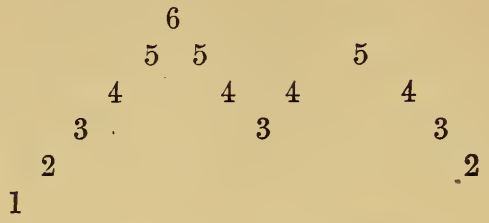
There is 8 ends in the pattern, and 8 goes into 64 just 8 times, therefore there will be 8 patterns per inch.

No. 1 stave.	8	stitches	per	in.	$8 \times 4 = 32$'s	counts	of	healds.
No. 2 „	16	„	„		$16 \times 4 = 64$	„		„
No. 3 „	16	„	„		„	„		„
No. 4 „	16	„	„		„	„		„
No. 5 „	8	„	„		$8 \times 4 = 32$'s	„		„

When the looming is irregular, the same method is adopted to find the counts of healds on each stave.

Example—A pattern of cloth is made with the loom-

ing given below, using a 70 reed, what is the counts of the healds on each stave?



Number of threads in the pattern = 14.

70 ÷ 14 = 5 complete patterns per inch.

No. 1	stave.	5	stitches	per	in.	5 × 4 = 20's	counts	of healds.
No. 2	,,	10	,,	,,		10 × 4 = 40's	,,	,,
No. 3	,,	15	,,	,,		15 × 4 = 60's	,,	,,
No. 4	,,	20	,,	,,		20 × 4 = 80's	,,	,,
No. 5	,,	15	,,	,,		15 × 4 = 60's	,,	,,
No. 6	,,	5	,,	,,		5 × 4 = 20's	,,	,,

A better system would be to have the healds knit to the pattern. This would prevent the threads from rubbing, and each stitch would be knit in its proper position on each stave.

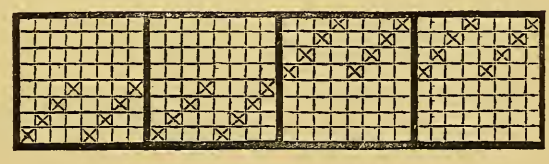
The stitches per inch on four staves gives the rate of knitting or the counts of the healds, the number also gives the wheel to use at the knitting machine. A knitting machine is so constructed that by means of a pegged lattice worked by a dobby a stitch can be missed or knit in any desired order.

The finest knit stave in the above draft is No. 4, which is knit at the rate of 80 per in. (on a basis of 4 staves), Taking this as the rate, all the other healds can be knit at the same rate, knitting a stitch or missing one as may be desired to suit the pattern. Taking the knitting for one inch on each stave, the order is given below. K = knit, M = miss.

Staves.	Rate per inch.	Stitches knit and missed.		Stitches knit on 1 inch of each stave.
1	80	K1 M3	(5 times)	5
2	,,	K1 M2 K1	,,	10
3	,,	K1 M1 K2	,,	15
4	,,	K4	,,	20
5	,,	M1 K3	,,	15
6	,,	M1 K1 M2	,,	5
				70

70 threads per inch is knit on the 6 staves to correspond with the 70 reed used.

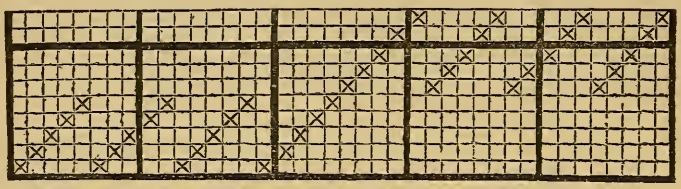
Another example is given below on 8 staves where the healds are spaced.



Using a 68 reed, the rate will be 68 per inch (based on 4 staves). The order of knitting is—

Staves 1 to 4 : Knit 4, miss 4.
Staves 5 to 8 : Miss 4, knit 4.

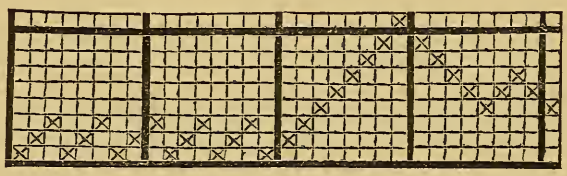
Another example is given on 10 staves, using a 60 reed. The rate for 5 shafts will be $\frac{60 \times 4}{5} = 48$.



The order of knitting will be—

Staves 1 to 5—rate 48 : Knit 4, miss 4.
„ 6 to 10 „ Miss 4, knit 4,

Another example is given on 9 staves, using a 60 reed.



The staves which contain the most stitches in one repeat are the first three. To find the rate of knitting for these, $\frac{60 \times 4}{3} = 80$.

Taking 80 as the rate, the stitches are knit and missed on the other staves as required. The number of the first staves (3) will, in this case, divide into 33, exactly the number of ends in one repeat of the pattern. The distance between one stitch and another on the front staves equals 2 or a K and a M together = 3 as the space or threads occupied. The pattern occupies 33 ends, which equals 11 K and M combined. As there

are 6 stitches knit on the 1st, 2nd, and 3rd staves in one repeat, the difference between 6 and 11, namely 5, will be the number to miss. The order of knitting is therefore—

Staves	Rate.	Stitches Knit and Missed.	Value of K & M.	Total. K & M.	Threads Repre-sented.	Stitches Knit on this Stave in One Repeat.
1	80	K6 M5	3	11	33	6
2	„	„ „	„	„	„	6
3	„	„ „	„	„	„	6
4	„	M6 K1 M2 K2	„	„	„	3
5	„	M6 K1 M1 K3	„	„	„	4
6	„	M6 K1 M2 K2	„	„	„	3
7	„	M7 K1 M1 K1 M1	„	„	„	2
8	„	M7 K2 M2	„	„	„	2
9	„	M8 K1 M2	„	„	„	1
						33 ends in one repeat.

The wheels which can be used on a knitting machine range from 20 to about 144.

Other systems of ascertaining the counts of reed are mentioned in works on weaving. The Bolton counts is based on the number of beers on 24¼ inches. A beer consists of 20 dents.

There are two Scotch systems. One of them is based on the number of hundredth splits on 37 inches. The other is based on the number of porters on 37 inches. A porter equals 20 dents.

CHAPTER III.

LOOM CALCULATIONS.

Taking-Up Motions.

There are two kinds in common use; one consists of a train of five wheels, sometimes termed the "old motion"; the other consists of a train of seven wheels, and is known as "Pickles' motion."

In making the calculations for the taking-up motion, it is usual to obtain the dividend, a number which, if used for a change wheel, would give one pick per quarter-inch in the loom. After the cloth is released from the tension of the loom, the picks get closer together, and to allow for this contraction $1\frac{1}{2}$ per cent. is added to the dividend. The dividend, with $1\frac{1}{2}$ per cent. added, is therefore a number which if used for a change wheel will give one pick per quarter inch counted on the counter.

Having obtained the dividend, to find the change wheel to use for any pick, or to find the pick any change wheel will give—

$$\frac{\text{Dividend}}{\text{Change wheel}} = \text{picks per quarter inch.}$$

$$\frac{\text{Dividend}}{\text{Picks per quarter inch}} = \text{change wheel.}$$

Fig. 3 illustrates the old motion and its working.

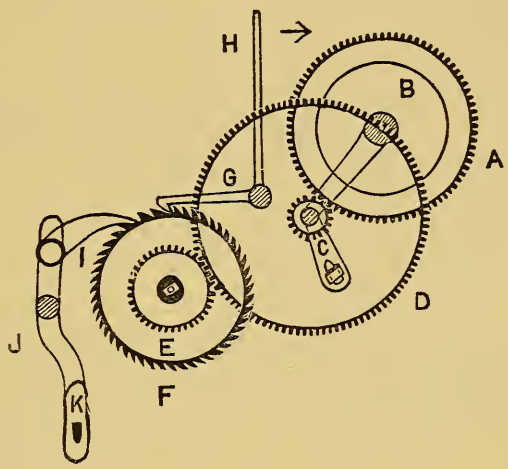
The following wheels are used :—

F—Rack wheel, 60 teeth.
D—Stud wheel, 140 „
A—Beam wheel, 78 „
C—Small pinion, 15 „
B—Circumference of beam, 58 $\frac{1}{4}$-ins., or $14\frac{1}{2}$ inches.

Different makers use different wheels.

The lever J is worked by means of a short stud K fixed to the slay sword, the pawl I attached to the lever pushes forward the wheel F one tooth each pick,

FIG. 3.



the pawl G prevents the wheel slipping back; the short lever H is pulled back so as to lift the pawl G, when the weft breaks to stop taking up. E equals change wheel.

Rack wheel, }
Stud ,, } multiplied together.
Beam ,, }

equals

Small pinion, }
Circumference of beam in quarter inches, } multiplied together.
Dividend, }

If any factor is required divide by that group to which it belongs.

Therefore dividend required —multiply rack, stud, and

beam wheels together, and divide by small pinion and circumference of beam in quarter inches, thus—

```
          140
           60
        ------
   58     8400
   15       78
  ---   ------
  290    67200
   58    58800
  ---   ------
  870 ) 655200 ( 753·1
        6090     11·2   1½ per cent. added for contraction
        ----    -----
        4620    764·3   =  dividend.
        4350   ------
        ----
        2700
        2610
        ----
         900
         870
         ---
```

Suppose that a 40 change wheel is used; to find the picks per quarter inch—

```
40 ) 764 ( 19·1 picks per quarter inch.
     40
     ---
     364
     360
     ---
      40
      40
      --
```

Sometimes questions are given thus :—

Give a train of wheels and the size of the beam to give 24 picks per quarter inch.

It has been stated that the dividend divided by the change wheel gives picks, therefore the picks multiplied by the change wheel gives dividend; also that if the rack, stud, and beam wheels are multiplied together, and divided by the pinion, circumference of beam in quarter inches, and the dividend, the numbers will cancel.

Therefore take any number for a change wheel, say 25, then picks 24 and change wheel 25 multiplied together gives 600 dividend. Take any number, say 15, for small

pinion, and say 60 quarter inches circumference of beam in quarter inches, we have now the following numbers—

Cir. of beam in quarter inches,	60
Small pinion, - - -	15
Picks per quarter inch, -	24 } = dividend.
Change wheel, - - -	25 }

Three wheels, namely, stud, rack, and beam, are now required, and the three numbers multiplied together must equal the four numbers stated above multiplied together thus—

Rack.		Beam.		Stud.
60	×	75	×	120

60	×	15	×	25	×	24
Cir. of beam.		Pinion.		Change wheel.		Picks.
				Dividend.		

The change wheel is split into two factors, 5×5, then $5 \times$ pinion $= 75$ teeth in beam wheel, $5 \times$ picks $= 120$ teeth in stud wheel, and the 60 rack wheel cancels the 60 circumference of beam.

Fig. 4 illustrates the parts of Pickles' taking-up motion.—The principle upon which this motion is based is that the number of teeth in the change wheel equals the number of picks per inch put into the cloth counted on the counter. The following seven wheels, along with the circumference of beam in quarter inches, are used—

A—Beam wheel, 89 teeth,	multiplied together.
D—Stud wheel, 90 ,,	
H—Rack wheel, 24 ,,	
Dividend.	

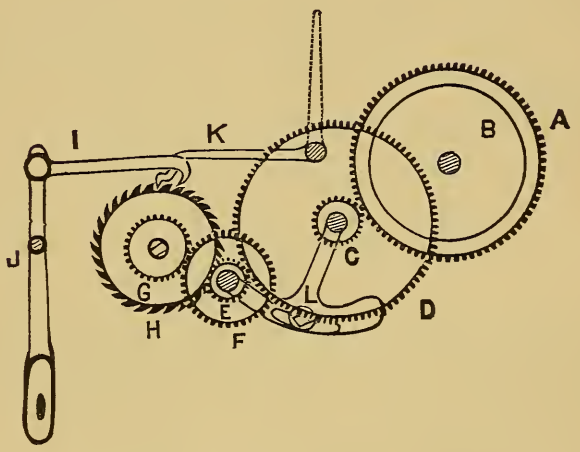
equals

B—Cir. of beam in quarter inches, 60·2,	multiplied together.
C—Pinion, 15 teeth,	
E—Swing pinion, 24 ,,	
G—Rack stud wheel, 36 ,,	

The lever J is worked from the slay sword, the pawl I pulls forward the rack wheel one tooth each pick, the pawl K prevents the wheel slipping back.

F—Change wheel.

FIG. 4.



If any factor is missing divide by that group to which it belongs. Dividend required. Therefore

$$\frac{60{\cdot}2 \times 15 \times 24 \times 36}{89 \times 90 \times 24} = 4{\cdot}06 \text{ dividend.}$$

If it were possible to use a wheel of 4·06 teeth, it would give one pick per quarter inch in the loom but, more than one pick per quarter out of the loom; therefore to allow for this contraction deduct $1\frac{1}{2}$ per cent. from 4·06, thus—

$4{\cdot}06 \times 1\frac{1}{2} = 6{\cdot}09 \div 100 = {\cdot}06$, therefore $4{\cdot}06 - {\cdot}06 = 4$

That is, a wheel of 4 teeth gives one pick per quarter, or 4 picks per inch, a wheel of 40 teeth gives 40 picks per inch, and so on.

The rack stud wheel G is sometimes changed in addition to the change wheel proper.

Example—Suppose that 60 picks per inch are required, then—

36 rack stud wheel and 60 change wheel, or any ratio of these two numbers, say :

27 rack stud wheel and 45 change wheel.
18 „ „ 30 „
54 „ „ 90 „

Strain on the Yarn due to the Dwell on the Tappet.

The strain is just in proportion to the dwell, greater the time allowed for dwell, and greater the strain, on account of the less time given for the change.

Example—Two looms are running at the same speed, same size of shed, and all other particulars the same, except that the dwell on the tappet in one loom is equal to half a pick, the dwell on the tappet in the other loom is a quarter of a pick.

The relative strains on the two warps will be as 2 to 1.

The tappet with a half a pick dwell gives the greater strain.

Example—Two looms, A and B, are working with the same size of shed. A runs 160 picks per minute with a tappet two-thirds of a pick dwell. B runs 200 picks per minute with a tappet one-third of a pick dwell. What are the relative strains on the two warps ?

Relative strain due to dwell is 2 to 1.

A is represented by 2. B is represented by 1. Strain due to speed of looms :

$$A = 2 \times 160 = 320. \quad B = 1 \times 200 = 200.$$

Taking the strain in B to equal 1, the strain in A will equal $320 \div 200$:

$$\begin{array}{r} 200 \,)\, 320 \,(\, 1{\cdot}6 \\ 200 \\ \hline 1200 \\ 1200 \\ \hline \end{array}$$

Therefore if the strain on the yarn in the loom B equals 1, the strain on the yarn in loom A equals 1·6.

Strain on the Yarn in Shedding.

The strain on the yarn in shedding varies as the square of the space passed through.

Example—Two looms are running at the same speed, the same dwell on the tappet in both, and all the other particulars are the same. The size of the shed at the healds in one loom is 4 inches; the size of the shed at the healds in another loom is 5 inches. The relative strain on the two warps will be as 4 squared is to 5 squared, or as 16 is to 25, the smaller shed giving the least strain.

If the loom with a 4-inch shed is running 190 picks per minute, and the loom with a 5-inch shed 160 picks per minute, all the other particulars being the same in both, the relative strains will be

$$4^2 \times 190 = 16 \times 190$$

$$\begin{array}{r} 16 \\ \hline 1140 \\ 190 \\ \hline 3040 \end{array}$$

$$5^2 \times 160 = 25 \times 160$$

$$\begin{array}{r} 25 \\ \hline 800 \\ 320 \\ \hline 4000 \end{array}$$

$$\begin{array}{r|l} 3040 & 4000 \ (1{\cdot}31 \\ & 3040 \\ \hline & 9600 \\ & 9120 \\ \hline & 4880 \\ & 3040 \\ \hline & 1760 \end{array}$$

Taking the strain on the warp with a 4-inch shed to

equal 1, the strain on the warp in the 5-inch shed will equal 1·31.

Speed of Looms, Shafting, Gearing, and Tappets.

Looms are run at various speeds, in accordance with the work they have to perform. A plain loom, 36 or 40 inch reed space, runs about 220 or 240 picks per minute, a loom fitted with a double lift dobby 200 picks per minute, with a double lift jacquard 160 to 180 picks, a double lift working with two cylinders 200 picks, circular and drop box looms 180 to 200 picks per minute.

The following method will show how to find the speed of the shaft, size of driving drum, size of loom pulley, or speed of loom—

Speed of shafting, Size of drum, } multiplied together

equals

Size of pulley, Speed of loom, } multiplied together.

If one of the factors is missing divide by that group to which it belongs.

Example—The speed of a loom is 220 revolutions per minute, the size of drum on line shaft is 14 inches, the line shaft makes 110 revolutions per minute. From the above example every possible case will be proved.

Find the size of the loom pulley—

$$\frac{110 \times 14}{220} = 7 \text{ inches.}$$

Find the speed of the loom—

$$\frac{110 \times 14}{7} = 220 \text{ rev. per minute.}$$

Find the speed of the line shaft—

$$\frac{7 \times 220}{14} = 110 \text{ rev. per minute.}$$

Find the size of the drum—

$$\frac{7 \times 220}{110} = 14 \text{ inches.}$$

Find the size of the drum and the size of the loom pulley.

In this case the speed of the loom (220) gives the size of the drum, the speed of the shafting (110) gives the size of the pulley. When these numbers are too large for practical purposes, any ratio of the two numbers will do. Thus, any two numbers which bear a ratio of 2 to 1, say, 14 inch drum ; 7 inch pulley.

Example—What is the size of the pulley which drives a loom 230 picks per minute ; the drum on line shaft is 15 inches diameter, and makes 130 revolutions per minute ; allow 10 per cent. for slip ?

The speed is 230 picks per minute.
10 per cent. for slip, 23
253 picks per minute is the speed at which the loom would run if there were no loss of power.

Therefore

$$\frac{130 \times 15}{253} = 7{\cdot}7 \text{ inches size of pulley.}$$

Example—What is the quickest time in which a piece of cloth can be woven which is made to the following particulars ?

32 inches wide, 116 yards long, 80 threads per inch, 80 picks per inch, 36 inches to the yard ; allow 13 per cent. for stoppages and 10 per cent. for slip ; the drum on line shaft is 15 inches diameter, making 115 revolutions per minute, loom pulley $7\frac{1}{2}$ inches diameter.

Let this calculation be worked as per below :—

Speed of loom—

$$\frac{15 \times 115}{7\frac{1}{2}} = 230$$

Less 10 per cent. for slip = 230 – 23 = 207.

Less 13 per cent. for stoppages = 207 – 27 = 180.

The speed of the loom therefore is 180 picks per minute. The number of picks of weft in the cloth—

```
  80 picks per inch.
  36 inches in a yard.
 ----
 480
240
----
2880 picks per yard.
 116 yards length of cloth.
-----
17280
 2880
2880
------
334080 picks of weft in the piece.
```

The picks in the cloth divided by the speed of the loom will give the minutes required to weave the cloth. Therefore

```
180 ) 334080 ( 1856 minutes.
      180
      ---
      1540
      1440
      ----
       1008
        900
       ----
        1080
        1080
       ====

60 ) 1856 ( 30 hours 56 min.
     180
     ---
      56
     ==
```

Carrier wheels are left out of the calculation in a train of wheels.—They are introduced for the purpose of conveying the motion from one wheel to another. If the wheels are too far apart, a carrier wheel is employed to convey the motion from one wheel to the other.

Example—A wheel A of 80 teeth gears direct and

drives a smaller wheel of 40 teeth B (fig. 5). One complete revolution of A takes B twice round. If a wheel C is introduced, as in fig. 6, it makes no difference to the speed of B.

FIG. 5.

FIG. 6.

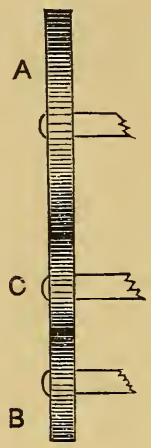
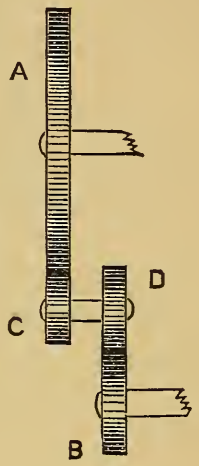


FIG. 7.



If two wheels are introduced (fig. 7), and they are both on the same stud, one of them, say the wheel C of 20 teeth in gear with the driver A of 80 teeth, also the wheel D of 30 teeth in gear with the driven wheel B of 40 teeth. To find the speed of B in relation to the speed of A the calculation stands thus—

$$\frac{80 \times 30}{40 \times 20} = 3$$

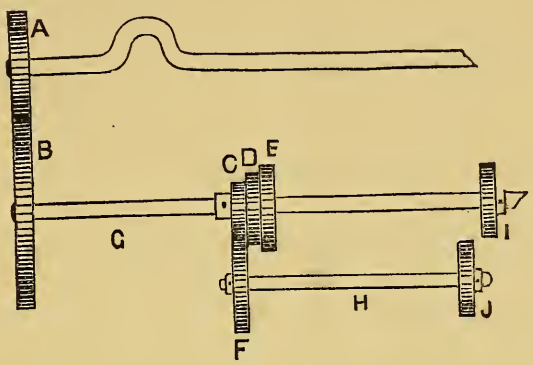
or B makes three revolutions for each revolution of the wheel A.

SPEED OF TAPPETS.

In weaving jeans, twills, and satins the tappets are generally fixed under the loom. By this means the looms take up less room than would be the case if they were fixed at the side of the loom.

Fig. 8 illustrates the train of wheels and methods of driving.

FIG. 8.



A is the crank shaft wheel driving the bottom shaft wheel B. Underneath the loom, fixed to the bottom shaft G, are three wheels, C, D, and E, cast in one piece. The shaft H is a countershaft which carries the tappets, and is fixed just beneath the shaft G. Any of the three wheels, C, D, and E, can be made to gear with the wheel F, which is fixed to H.

The number of teeth in the respective wheels are—

A, 48 teeth—driver.
B, 96 „ driven.
C, 16 „ driver. Used for 5 picks to the round.
D, 22 „ „ „ 4 „ „
E, 24 „ „ „ 3 „ „
I, 30 „ „
J, 30 „ driven.
F, change wheel—driven.

or

Drivers
Picks to the round, } multiplied together

equals

Driven wheels, } multiplied together.

If one of the factors is missing, divide by that group to which it belongs.

Example—What must be the number of teeth in the wheel F to give three picks to the round?

$$\frac{\overset{A}{48} \times \overset{E}{24} \times 3 \text{ picks to the round}}{\underset{B}{96}} = 36 \text{ F.}$$

To give four picks to the round—

$$\frac{\overset{A}{48} \times \overset{D}{22} \times 4 \text{ picks to the round}}{96} = 44 \text{ F.}$$

To give five picks to the round—

$$\frac{\overset{A}{48} \times \overset{C}{16} \times 5 \text{ picks to the round}}{96} = 40 \text{ F.}$$

When plain cloth is woven the wheels C, D, or E, are put out of gear with the wheel F, and I is put into gear with J thus :—

$$\frac{\overset{B}{96} \times \overset{J.}{30}}{\underset{A}{48} \times \underset{I}{30}} = 2 \text{ picks to the round.}$$

In the above arrangement three separate wheels are used to obtain the three different speeds. Another method is to use a constant wheel F, containing 60 teeth, the other wheels being—

A, 48 teeth—driver.
B, 96 „ driven.
C, 24 „ driver.
D, 30 „ „
E, 40 „ „

Wheels to use for three picks to the round—

$$\frac{\overset{B}{96} \times \overset{F}{60}}{\underset{A}{48} \times \underset{E}{40}} = 3 \text{ picks to the round.}$$

Wheels to use for four picks to the round—

$$\frac{\overset{B}{96} \times \overset{F}{60}}{\underset{A}{48} \times \underset{D}{30}} = 4 \text{ picks to the round.}$$

Wheels to use for five picks to the round—

$$\frac{\overset{B}{96} \times \overset{F}{60}}{\underset{A}{48} \times \underset{C}{24}} = 5 \text{ picks to the round.}$$

If any two wheels are left out of the train, say a driver and a driven, then—

Picks to the round multiplied by drivers gives the driven wheel required, and driven wheels multiplied together gives the driving wheel required; or any ratio of the two numbers.

Example—Using the wheels last mentioned, what wheels, driving and driven, C and B, must be used to give 5 picks to the round? The other wheels being A 48 and F 60.

$\overset{A}{48} \times 5$ picks to the round = 240, driven wheel required.

$\overset{F}{60}$ gives the driving wheel required.

These two numbers are too large for practical purposes, therefore any two numbers which bear a ratio of 4 to 1, say 96 driven and 24 driver.

Side Tappets.—The driving of the tappets fixed at the side of the loom is brought about by having a tappet wheel of 120 teeth and a wheel on the crank shaft of

40 teeth for 3 picks to the round.
30 ,, 4 ,,
24 ,, 5 ,,

To enable the different sized wheels on the crank shaft to gear with the tappet wheel a carrier wheel is used to convey the motion from one wheel to the other. The

number of teeth in the carrier wheel makes no difference to the speed of the tappets.

If it is required to drive the tappet 7 picks to the round, using a tappet wheel of 120 teeth, then no number will divide exactly 7 times into 120; therefore, intermediate wheels must be used, thus—using a 20 crank wheel and 120 tappet wheel.

Fig. 9.

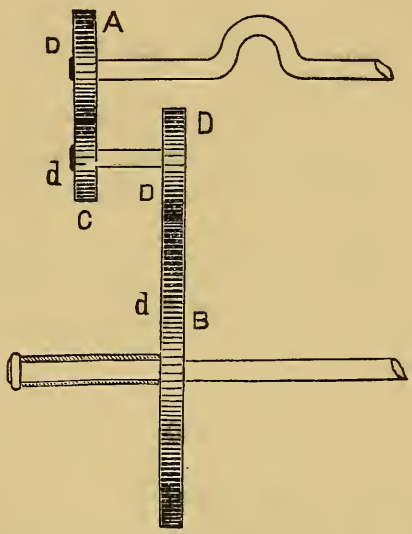


Fig. 9.—A is the crank wheel, B tappet wheel, C and D intermediate wheels. Split the wheels up into driving and driven—let D = drivers and d = driven.

To find C and D, a driven and a driver.

A

Picks to the round $7 \times 20 = 140$, driven wheel required.

Driven wheel 120, driving „

or any ratio of these two numbers,

Say—C = 28 and D = 24

Every case will be proved, taking the particulars given in fig. 9.

Find picks to the round—

$$\frac{\overset{B}{120} \times \overset{C}{28}}{\underset{D}{24} \times \underset{A}{20}} = 7 \text{ picks to the round.}$$

Find crank wheel A—

$$\text{Picks to the round} \quad \frac{\overset{B}{120} \times \overset{C}{28}}{\underset{D}{7} \times 24} = 20 \text{ A}$$

Find driven wheel C—

$$\text{Picks to the round} \quad \frac{\overset{A}{7} \times \overset{D}{20} \times 24}{\underset{B}{120}} = 28 \text{ C}$$

Find driving wheel D—

$$\text{Picks to the round} \quad \frac{\overset{B}{120} \times \overset{C}{28}}{7 \times \underset{A}{20}} = 24 \text{ D}$$

Find driven wheel B—

$$\text{Picks to the round} \quad \frac{\overset{A}{7} \times \overset{D}{20} \times 24}{\underset{C}{28}} = 120 \text{ B}$$

Find the speed of B—

$$\frac{\overset{A}{20} \times \overset{D}{24}}{\underset{C}{28} \times \underset{B}{120}} = \tfrac{1}{7} \text{ speed of crank shaft.}$$

Levers.

In calculations bearing on the size of shed, stroke of tappet, &c., it is requisite that the student should understand the principle of the lever.

Taking a few simple examples, its action will be clearly understood.

Example—A treadle is 18 inches long from the treadle heel to the point where the healds are attached; the treadle bowl 9 inches from the treadle heel; the stroke of the tappet 2 inches. Through what distance does the end of the lever move when the tappet acts?

Stroke of tappet
The whole length of the treadle, } multiplied together
equals
Length of treadle from treadle bowl to heel,
Distance through which the end of the treadle moves, } multiplied together.

If one of the factors is missing, divide by that group to which it belongs. Therefore

$$\frac{2 \times 18}{9} = 4 \text{ inches distance through which the end of the treadle moves.}$$

Same particulars, find stroke of tappet.

$$\frac{9 \times 4}{18} = 2 \text{ inches.}$$

Find the length of the treadle.

$$\frac{9 \times 4}{2} = 18 \text{ inches.}$$

Find length of treadle from treadle heel to treadle bowl.

$$\frac{2 \times 18}{4} = 9 \text{ inches.}$$

In cross rod looms where there is a top lever, one arm of the lever is attached to the healds, the other arm to the rod attached to the treadle, the fulcrum of the lever being somewhere between these two points.

Example—A lever is fulcrumed in the centre. The length of the arms on each side is 6 inches. It will be

clear that if the end of one arm moves through a space of 3 inches, the end of the other arm will move through the same space in the opposite direction, so that the distance through which the ends of the arms move is in proportion to the length of the arms. If one of the arms is shortened to 3 inches, the end of that arm only moves through half the space of the other arm, which is 6 inches long.

Example—In a cross rod loom the end of the treadle which is attached to the long upright rod moves through a space of 3 inches. The size of the shed at the healds is 4 inches. What are the respective lengths of the arms on the top lever?

The length of the arm attached to the healds is 4 inches; the length of the arm attached to the rod connected with the treadle is 3 inches, or any ratio of these two numbers; multiplying them both by 2, say 8 and 6.

Size of the Shed and the Stroke of the Tappet.

The size of the shed at a point in front of the shuttle, when the reed is thrown back, is slightly larger than the depth of the shuttle used. If the shuttle measures $1\frac{1}{2}$ inches broad by $1\frac{1}{8}$ inches deep; the distance from the fell of the cloth to the reed, when the slay is at its furthest extremity from the fell of the cloth is $4\frac{3}{4}$ inches; then at $4\frac{3}{4}$ inches, less $1\frac{1}{2}$ inches, the width of the shuttle, namely, $3\frac{1}{4}$ inches, from the fell of the cloth, the depth of the shed must be at least $1\frac{1}{8}$ inches, the depth of the shuttle, otherwise the shuttle will not be able to freely pass through the shed. In practice a clearance is generally allowed of about $\frac{1}{8}$ or $\frac{1}{4}$ of an inch.

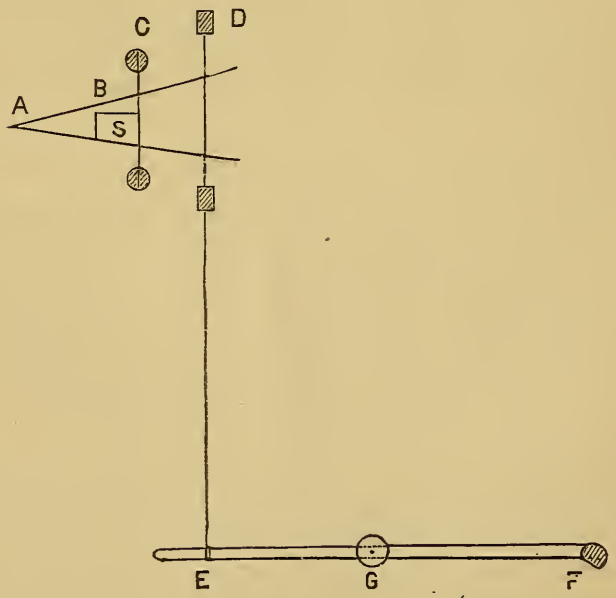
After it has been determined what the size of the shed shall be, the sweep of the slay, distance of the

healds from the fell of the cloth, length of treadles, and the position of the treadle bowl, the stroke of the tappet has to be considered.

Example—Find the stroke of the tappet. The other particulars are :—Sweep of slay, $4\frac{3}{4}$ inches; distance of healds from fell of cloth, 8 inches; length of treadle, 22 inches; the healds are attached at a point $17\frac{1}{2}$ inches from the treadle heel; treadle bowl, 10 inches from the treadle heel; size of shuttle used, $1\frac{1}{8}$ inches deep, $1\frac{1}{2}$ inches broad, allowing a clearance of an $\frac{1}{8}$ of an inch.

The calculation will be best understood and worked from the diagram, fig. 10.

Fig. 10.



A—Fell of cloth. B—A point in front of the shuttle. C—Reed when at its furthest extremity from the fell of

the cloth. D—Healds. E, G, F—Treadle. G—Treadle bowl.

A to B = $3\frac{1}{4}$ inches.
A to C = $4\frac{3}{4}$ „
A to D = 8 „

Size of shed at B = $1\frac{1}{4}$ inches = $1\frac{1}{8}$ inches for depth of shuttle and $\frac{1}{8}$ inch for clearance.

The size of the shed at $3\frac{1}{4}$ inches from the fell of the cloth is $1\frac{1}{4}$, what will it be at the healds, 8 inches from the fell of the cloth? Greater. Therefore

$$1\frac{1}{4} \times 8 \div 3\frac{1}{4} = 3{\cdot}07 \text{ inches.}$$

To produce this size of shed, the healds are attached at $17\frac{1}{2}$ inches from the fulcrum of the treadle. The treadle is acted upon by means of a tappet at 10 inches from the fulcrum. The treadle is moved through a space of 3·07 inches at $17\frac{1}{2}$ inches from the end. Through what space will it be moved at 10 inches from the end? Less. Therefore

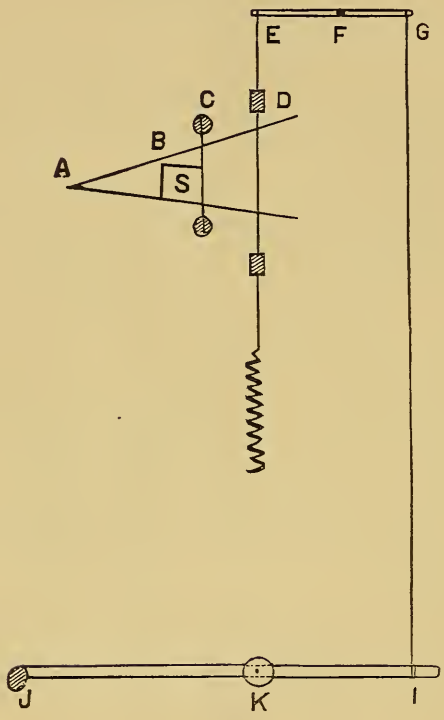
$$3{\cdot}07 \times 10 \div 17\frac{1}{2} = 1\frac{3}{4} \text{ inches stroke of tappet.}$$

If the tappets are fixed at the side of the loom, the arrangement of levers is slightly different.

Example—Find the stroke of the tappet in a cross rod loom. The other particulars are:—Stroke of slay, 5 inches; from fell of cloth to healds, 9 inches; length of arms on top levers, $5\frac{1}{2}$ inches on that side to which the healds are attached, $6\frac{1}{2}$ inches on the other side; the rod from top lever is fixed to the treadle at 32 inches from the treadle heel or fulcrum; treadle bowl 22 inches from the fulcrum; shuttle used, $1\frac{1}{2}$ inches broad by $1\frac{1}{8}$ inches deep, allowing a clearance of an $\frac{1}{8}$ of an inch for the shuttle.

In fig. 11, A—Fell of cloth. B—Point in front of the shuttle. C—Reed when at its furthest extremity from

Fig. 11.



the fell of the cloth. D—Healds. E, F, G—Top lever. J, K, I—Treadle. K—Treadle bowl.

A to B = $3\frac{1}{2}$ inches.
A to C = 5 ,,
A to D = 9 ,,
E to F = $5\frac{1}{2}$,,
F to G = $6\frac{1}{2}$,,
J to I = 32 ,,
J to K = 22 ,,

The size of the shed at B, $3\frac{1}{2}$ inches from the fell of

the cloth, is—$1\frac{1}{8}$ inches depth of shuttle, plus $\frac{1}{8}$ inch for clearance $= 1\frac{1}{4}$ inches. What will it be at the healds, 9 inches from the fell of the cloth? Greater. Therefore

$$1\tfrac{1}{4} \times 9 \times 3\tfrac{1}{2} = 3{\cdot}2 \text{ inches.}$$

E goes up 3·2 inches, working on F as a fulcrum. How much does it go down at G? More, on account of F G being the longer arm. Therefore

$$3{\cdot}2 \times 6\tfrac{1}{2} \div 5\tfrac{1}{2} = 3{\cdot}78 \text{ inches.}$$

That is, the treadle is depressed 3·78 at 32 inches from the treadle heel. What is the amount of depression at the treadle bowl, 22 inches from the treadle heel? Less. Therefore

$$3{\cdot}78 \times 22 \div 32 = 2{\cdot}6 \text{ inches stroke of tappet.}$$

CHAPTER IV.

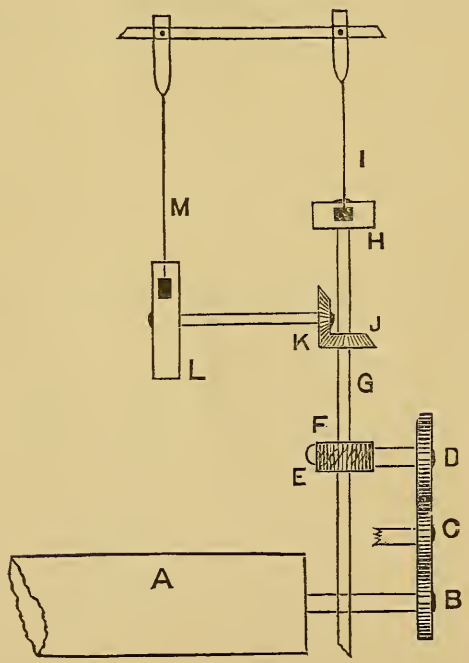
SLASHER AND BEAMING CALCULATIONS.

Slasher Measuring and Marking Motion.

Each machine is provided with a measuring roller and a train of wheels, for the purpose of measuring and marking the cuts the required length as they are wound on to the weaver's beam.

The measuring and marking motion is situated at the headstock, and within handy reach of the sizer, though all the measuring and marking is done automatically by the machine. Fig. 12 illustrates its parts.

Fig. 12



It consists of a measuring roller A, 14·4 inches in circumference, over which the yarn passes. On the end

of the roller is the tin roller wheel B, which gears with a carrier wheel C, which in its turn gears with the stud wheel D; on the same stud as the stud wheel is a worm E, driving the bell wheel F, which contains 45 teeth; on the bell wheel shaft is the marking cam H, on to which a hammer lever I rests; fixed to G is also a bevel wheel J, gearing with a similar wheel K, which is fixed to a short shaft; this shaft carries a circular disc of wood L, namely, the colour bowl, which revolves in a dish of colour fixed below it; the hammer lever M is fixed above the sheet of yarn, and the colour bowl below; for every complete revolution of the marking cam H the lever I drops down, as does likewise the lever M; one end of the last named lever comes in contact with the warp, striking it against the colour bowl, when the lever suddenly rebounds, but the contact has been sufficient to leave a smut of colour about an inch square on the warp. This is termed the cut mark, and indicates to the weaver when the cut is finished.

The circumference of measuring roller and wheels used are :—

Bell wheel, 45 teeth.
Circumference of measuring roller, 14·4 inches. } Multiplied together
Stud wheel.

equals

Tin roller wheel.
Length of mark in inches. } Multiplied together.

The number of teeth in the bell wheel is constant 45 teeth, the circumference of the measuring roller is constant 14·4 inches, and multiplied together they give

$$45 \times 14{\cdot}4 = 648.$$

In working out examples, the number 648 will be taken instead of circumference of roller and bell wheel.

If one of the factors is missing, divide by that group to which it belongs.

Example—To find tin roller wheel. In the measuring motion of the slasher an 80 stud wheel is used, find the tin roller wheel to mark every 36 yards.

Length of mark in inches $= 36 \times 36 = 1296$; therefore

$$\frac{648 \times 80}{1296} = 40 \text{ tin roller wheel.}$$

To find stud wheel—

Example—What stud wheel must be used to mark every 36 yards, using a 40 tin roller wheel?

$$\frac{1296 \times 40}{648} = 80 \text{ stud wheel.}$$

To find length of mark in inches—

Example—What length of mark will an 80 stud wheel and a 40 tin roller wheel give?

$$\frac{648 \times 80}{40} = 1296 \text{ inches.}$$

Generally both stud and tin roller wheels are to find.

Example—What stud and tin roller wheels must be used to mark every 36 yards?

In cases of this kind,

648 gives tin roller wheel.

Length of mark in inches gives stud wheel.

These numbers will be too large for practical use, therefore any ratio of the two numbers will do.

648 gives tin roller wheel.

1296 gives stud wheel,

or any two wheels which bear a ratio of 2 to 1, the stud

wheel having double the number of teeth to the tin roller wheel, namely—

40 tin roller wheel.
80 stud wheel.

There are many lengths where the wheels are not so easily obtained as in the example just given.

Example—What wheels, tin roller, and stud must be used to mark every 30 yards $21\frac{1}{2}$ inches?

Length of mark in inches =

36 inches in a yard.
30 yards.

1080
$21\frac{1}{2}$

$1101\frac{1}{2}$ inches.

648 gives tin roller wheel and $1101\frac{1}{2}$ gives stud wheel, or any ratio of these two numbers. Let 648 equal 1, then $1101\frac{1}{2}$ equals

648) 1101·5 (1·7 as near as possible.
648
4535
4536

Therefore tin roller wheel = 1 and stud wheel = 1·7. Multiply both numbers by one and the same number, and let the multiplier be such a number that it multiplies 1 and also 1·7 and leaves them in whole numbers. Say the multiplier is 60, then $1 \times 60 = 60$ tin roller wheel $1{\cdot}7 \times 60 = 102$ stud wheel.

Proof—What length of mark will a 60 tin roller wheel and 102 stud wheel give?

648
102 stud wheel.

1296
6480

66096

Tin roller wheel 60) 66096 (1101·6 inches.

60
60
60
96
60
360
360

1101·6 inches = 30 yards $21\frac{2}{3}$ inches.

In some cases the wheels are too large for practical purposes. It is usual then to use wheels which will give the nearest length, to the length of mark required.

Prepare a set of slashers back beams to make cloth to the following particulars :—

31 inches wide, 125 yards length, $\underbrace{\overset{\text{Reed.}}{19} \times \overset{\text{Pick.}}{20}}_{\text{Per } \frac{1}{4} \text{ inch.}}$, 40's twist, 50's weft, 131 pieces required.

Using a 72 reed.

The tapers particulars are—

2240 ends, 17500 yards length; 2 marks to a cut, length of mark 66 yards 24 inches; 4 beams 450 ends, 1 beam 440 ends = 2240 ends.

Calculation weight equals

$$\frac{2240 \times 17500}{840 \times 40} = 1166{\cdot}6 \text{ lb.}$$

17500 ÷ 66 yards 24 inches = 262 marks, or 131 pieces of 2 marks to a cut, and a fent of about 33 yards over.

Wheels—

66 yards 24 inches = 2400 inches.

$\frac{2400}{648} = \frac{100}{27}$ stud wheel.
tin roller wheel.

Weight of Size on Yarn.

If 5 per cent. of size is added to 100 lb. of yarn, the total weight is then 105 lb., obtained thus—

$$\begin{array}{r} 100 \\ \times\ 5 \\ \hline 100 \overline{)\ 500} \\ 500 \\ \hline \end{array} \quad (\ 5$$

5 plus 100 = 105. That is, multiply the amount of yarn by the amount per cent. and divide by 100.

125 lb. of yarn is sized to the extent of 8 per cent. How much size is put on?

$$\begin{array}{r} 125 \\ \times\ 8 \\ \hline 100 \overline{)\ 1000} \\ 1000 \\ \hline \end{array} \quad (\ 10 \text{ lb.}$$

Or the contrary of this, if 125 lb. of yarn carry 10 lb. of size, so that the total weight is 135 lb. How much is that per cent.?

Add two cyphers to the amount of size used, and divide by the amount of yarn sized.

$$125 \overline{)\ 1000} \quad (\ 8 \text{ per cent.}$$
$$1000$$

To find the percentage of waste made in yarn, in any of the departments of the mill.

Add two cyphers to the weight of waste, and divide by the weight of yarn from which it is made.

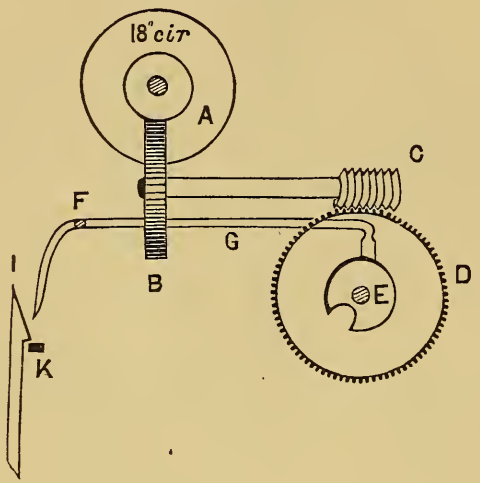
Example—60 lb. of weft is supplied to a weaver, and 2 lb. of waste is returned. How much is that per cent.?

$$60 \overline{)\ 200} \quad (\ 3{\cdot}3 \text{ per cent.}$$
$$18$$
$$\overline{20}$$
$$18$$
$$\overline{20}$$

Beaming Frame.

The measuring motion (fig. 13) consists of a roller 18 inches in circumference, over which the yarn passes and carries it round.

Fig. 13.



On the end of the shaft on which the roller is fixed is a worm A driving the wheel B ; on the same stud as B is another worm C, driving the wheel D ; the measuring roller is 18 inches in circumference ; the wheel B contains 70 teeth, the wheel D 100 teeth ; therefore one revolution of the measuring roller, having a worm on one end, takes one tooth only of the wheel B, will equal half a yard for one complete revolution of B, having 70 teeth, 70 half yards or 35 yards will have passed the measuring roller ; one revolution of B, having a worm on the same stud, takes one tooth of the wheel D, therefore one tooth of D equals 35 yards ; when D has made one complete revolution $35 \times 100 = 3500$ yards have passed the measuring roller. This length is generally termed a

wrap, and five wraps are generally wound on to a beam. To ensure the machine stopping at the end of every wrap, there is fixed to the wheel D a circular plate E, with a depression on one side ; resting on the upper side of this plate is the hammer lever G, with its fulcrum at F ; the other end of the lever is in close contact with the trigger I ; when the depression in the plate E comes to the top, the end of the lever G drops into it ; the other end of the lever coming in contact with I knocks it off the support K, and stops the machine.

The measuring motion ought to be kept in good order to prevent the warping of irregular lengths. If the length of yarn on one beam is 50 yards short, and this beam is put up at the slasher along with five others, it will have delivered all its yarn when there is still 50 yards on each of the other five beams. This means $5 \times 50 = 250$ yards of waste, as well as taking up a considerable time, balling the yarn off the beams.

CHAPTER V

Examination Questions and Answers.

Example—What is the counts of a double thread 20's and 40's twisted together? (O. 1890 C. G.)

$$\frac{1000}{20} = 50$$

$$\frac{1000}{40} = \frac{25}{75}$$

75) 1000 (13·3's counts.

75

250

225

250

225

25

Example—How much 60's twist will you require for a set of slashers beams, the whole set to contain 2360 ends 18000 yards? (O. 1890 C. G.)

2360 ends.

18000 length.

18880000

2360

840 × 60 = 50400) 42480000 (842·85, or 842 lb. 13½ oz.

403200

216000

201600

144000

100800

432000

403200

288000

252000

36000

Example—In weaving 8-end satin 40 inches in reed, 56 reed Stockport counts, how many healds would you require on each stave in two inches? Also how many healds on each stave if for a 14-end pattern, drawn in on 8 staves centred backward and forward? (O. 1890 C. G.)

In the first case there will be 7 stitches per inch on each stave, or 14 stitches on every 2 inches. In the second case the looming is

8
7 7
6 6
5 5
4 4
3 3
2 2
1

14 ends in the pattern, $56 \div 14 = 4$ complete patterns per inch. Therefore on staves 1 and 8 there will be 4 stitches per inch, or 8 stitches per 2 inches; on staves 2, 3, 4, 5, 6, and 7 there will be 8 stitches per inch, or 16 stitches on every 2 inches. Therefore on

No. 1	stave	there are	4	stitches per inch =	16's sett.
No. 2	,,		8	,,	32's ,,
No. 3	,,		8	,,	32's ,,
No. 4	,,		8	,,	32's ,,
No. 5	,,		8	,,	32's ,,
No. 6	,,		8	,,	32's ,,
No. 7	,,		8	,,	32's ,,
No. 8	,,		4	,,	16's ,,

Example—What size of pulley will you require on a loom to give 168 picks per minute, if the driving drum is 14 inches, on a shaft running 108 revolutions? (O. 1890 C. G.)

$$\frac{14 \times 108}{168} = 9 \text{ inches.}$$

Example—Draw the taking-up motion you are accustomed to and give the train of wheels required to weave 112 picks per inch of cloth. Circumference of taking-up roller, 14 inches. (O. 1890 C. G.)

The number of picks per quarter = 28.

Circumference of beam in quarter inches = 56.

Therefore put down the numbers given thus—

$$\frac{\text{Rack wheel} \times \text{Stud wheel} \times \text{Beam wheel.}}{56 \times \text{P.} \times \underbrace{28}_{4 \times 7} \times \text{C.W.}}$$

The whole of these must cancel out.

Assume a change wheel of 16 teeth.
Assume a pinion of 18 teeth.

Then use a 56 rack wheel. 4 times 18 pinion gives 72 stud wheel, and 7 times 16 change wheel, gives beam wheel 112, thus—

$$\frac{56 \times 72 \times 112}{56 \times 18 \times 28 \times 16} = 0$$

This train of wheels will give 28 picks per quarter inch in the loom, and $1\frac{1}{2}$ per cent. more picks out of the loom.

Example—There are two looms running the same number of picks per minute, the moving parts of the lay, &c., being the same. In one loom there is a crank of 3 in. radius, with a 12 in. connecting arm ; in the other loom there is a crank of 4 in. radius, with an 11 in. connecting arm. Give the force exerted by the lay with the 4 in. crank in beating up, calling the force exerted by the 3 in. crank one. (Hon. 1890 C. G.)

The relative forces are—

$$3 \times 12 = 36^2$$
$$4 \times 11 = 44^2$$
$$36 \times 36 = 1296. \quad 44 \times 44 = 1936.$$

The 3 in. crank is taken as one, therefore the 4 in. crank equals $1936 \div 1296$—

$$1296 \overline{)1936} \ (1{\cdot}4$$

$$\begin{array}{r} 1296 \\ \hline 6400 \\ 5184 \\ \hline 1216 \end{array}$$

Nearly 1·5 or $1\frac{1}{2}$ is the force exerted by the lay with a 4 in. crank.

Example—An engine is driving a line shaft by ropes, and running 60 revolutions per minute, with a driving drum of 20 feet. Give a size for line shaft drum to be driven by engine drum, and speed of line shaft; also presuming you have mitre wheels on driving shafts of shed, from line shaft, give sizes of drum driving loom, and loom pulley to drive your loom, 180 picks per minute. (H. 1890 C. G.)

The mitre wheels of equal teeth will be the means of driving the shaft in the shed at the same speed as the line shaft driven from the engine.

Assuming a wheel of 10 ft. on the line shaft, the speed of this shaft will equal—

$$\frac{\text{Driving Drum.}\ 240 \text{ in.} \times \text{Engine Speed.}\ 60}{\underset{\text{Line Shaft.}}{\underset{\text{Drum on}}{120 \text{ in.}}}} = 120 \text{ rev. per min.}$$

The mitre wheels drive the shaft in the shed at 120 rev. per min.; the loom runs 180 rev. per min.: What are the sizes of the loom pulley and the drum on driving shaft?

The speed of the driver gives the size of the driven = 120
The „ driven „ „ driver = 180

When these numbers are two large for practical pur-

poses, any ratio of these two numbers will do, dividing them both by 10—

18 in., size of drum on driving shaft.
12 in., size of pulley on loom.

The rules for working examples of this kind are—

A train of wheels is put together so that when all the drivers are multiplied together by the speed of the drivers they will equal all the driven wheels multiplied together by the speed of the drivens, or the two lots of numbers will cancel.

In the above-mentioned train the drivers are—Driving drum 20 ft., engine speed 60, one of the mitre wheels, and drum on shaft in the shed. The drivens are—Drum on line shaft, one of the mitre wheels, loom pulley, and speed of loom. Therefore 20 ft. drum = 240 inches.

$$\frac{\text{Drivers—240 in. (Driving Drum.)} \times 60 \text{ (Engine Speed.)} \times 30 \text{ (Mitre Wheel.)} \times 18 \text{ (Driving Drum in Shed.)}}{\text{Drivens— 180 (Speed of Loom.)} \times 12 \text{ (Loom Pulley.)} \times 30 \text{ (Mitre Wheel.)} \times 120 \text{ in. (Drum on Line Shaft.)}} = 0$$

Example—What weight of yarn shall I dye of each colour to make a pattern warp, 2 blue, 2 yellow, 2 blue, 6 red, 2 blue, 2 yellow, 2 blue, the warp to contain 720 ends, 20's twist, 820 yards long, 5 per cent. allowed for waste ? (15). (O. 1891 C. G.)

Three colours are used, and the number of ends of each colour in one complete pattern are—

8 blue, 4 yellow, 6 red,

or 18 ends in all—720 ends ÷ 18 gives 40 complete patterns in the warp.

There are in the warp—

320 blue ends.
160 yellow ,,
240 red ,,
720 ends in all.

The weight of blue warp—

320 ends.
820 yards length.

840 × 20 = 16800 ; 320 × 820 = 262400

262400 (15·61 weight.
16800
94400
84000
104000
100800
32000
16800
15200

Plus 5 per cent. for waste. 5 per cent. = ·78, therefore 15·61 + ·78 = 16·39 lb. weight of yarn to be dyed blue.

Weight of yellow warp—

There is just half the number of ends of yellow to what there is blue, therefore there is half the weight.

16·39 ÷ 2 = 8·19 lb. weight of yarn to be dyed yellow.

Weight of red warp—

There is half as much again red as there is yellow, therefore weight of red equals.

8·19 + 4·09 = 12·28 lb. weight of yarn to be dyed red.

Example—What counts of yarn shall I double with 30's to produce 12's? (10.) (O. 1891 C. G.)

$$\frac{1000}{12} = 83\cdot3 \text{ Grs.}$$

$$\frac{1000}{30} = 33\cdot3$$

$$50\cdot$$

The difference between the weights of one lea of each divided into 1000 gives the counts required, therefore—

$$\frac{1000}{50} = 20\text{'s counts.}$$

Example—A warp of 1035 ends, 750 yards, weighs 33 lb., what is the counts? (10.) (O. 1891 C. G.)

$$\begin{array}{r} 1035 \\ 750 \\ \hline 51750 \\ 7245 \\ \hline 840 \times 33 = 27720 \,)\, 776250 \,(\, 28\text{'s counts.} \\ 55440 \\ \hline 221850 \\ 221760 \\ \hline 90 \end{array}$$

Example—What will be the relative strain in the shedding of two warps if one is weaving in a loom running 100 picks per minute, the shed being opened 3 ins. each pick, and the other weaving in a loom running 90 picks, the shed being opened 4 ins. each pick, the weighting of the warps being the same? (15.) (H. 1891 C. G.)

$$\begin{array}{r} 100 \times 3^2 = 900 \\ 90 \times 4^2 = 1440 \end{array}$$

Assuming the strain on the warp with the 3 in. shed equals one, the strain on the warp in the 4 in. shed equals $1440 \div 900$

$$\begin{array}{rr} = & 900 \,)\, 1440 \,(\, 1{\cdot}6 \\ & 900 \\ \hline & 5400 \\ & 5400 \end{array}$$

Example—Presuming that the relative diameters of cotton yarns are as the square root of their respective counts, what counts of yarn will give the same firmness in a 2 and 2 twill that 20's would give in plain cloth, the threads being equal in number both ways? (10.) (H. 1891 C. G.)

The ends plus intersections in 4 ends of the twill equals 4 ends + 2 intersections = 6.

The ends plus intersections in 4 ends of the plain equals 4 ends + 4 intersections = 8.

The square root of 20's = 4·47.

The counts of yarn for the twill will be coarser on account of fewer intersections. Therefore—

$$\begin{array}{rrl} & 4{\cdot}47 & \\ & 6 & \text{ends + intersections in plain.} \\ \text{Ends + intersections in twill} & 8\,)\,26{\cdot}82 & \\ & 3{\cdot}35 & \end{array}$$

and $3{\cdot}35^2 = 11\frac{1}{4}$'s counts.

Example—How much per yard (grey) will a sateen stripe cost woven to the following particulars:—Brocade stripe of 3 in. and sateen stripe of 2 in. (in reed) alternate, 40 in. wide in reed, brocade 2 in a dent, sateen 4 in a dent, twist 40's throughout, 64 reed Stockport, 96 picks per in., 30's weft; weaving, $\frac{3}{4}$d per yard; expenses, 10 per cent. more than weaving; cost of twist in loom, $14\frac{1}{2}$d per lb.; weft, $9\frac{1}{4}$d. (25.) (H. 1891 C. G.)

The number of ends in the warp equals:—

Brocade stripe of 3 in. 8 times = 24 in., 64 reed, 2 in a dent = $64 \times 24 = 1536$ ends. Sateen stripe of 2 in. 8 times = 16 in., 64 reed, 4 in a dent = $64 \times 16 \times$

2 = 2048 ends. Therefore total number of ends equals—

1536
2048
3584 ends.

Add 6% to cloth length 1·06 tapers length.

21504
35840

840 × 40 = 33600) 3799·04 (·11 lb. weight of warp.
33600·
43904
33600
10304

Weight of Weft— 40 in. width in reed.
96 picks per inch.

240
360
3840
1 cloth length.

840 × 30 = 25200) 38400 (·15 lb. weight of weft.
25200
132000
126000
6000

Cost—

	D.
Warp, ·11 lb. at 14½d per lb.	= 1·6
Weft, ·15 lb. at 9¼d „	= 1·4
Weaving, - - -	= 0·75
Expenses, - - -	= 0·82
Total cost	= 4·57 or 4½d per yard.

Example—You have 52½ lb. of 20's twist (less 5 per cent. waste in working) to make a warp of 700 yards; how many ends will it give? (15.) (O. 1892 C. G.)

52·5 lb., less 5 per cent.
2·6 = 5 per cent.
49·9 weight of yarn.

49·9 weight.
20's counts.
9980
840
399200
79840
Length = 700) 838320·0 (1197 ends in warp.
700
1383
700
6832
6300
5320
4900
420

Example—What value of weft only is there in a piece of cloth 50 yards long, with 1960 ends (allowing 40 for selvages), in a 60 reed, Stockport counts, 20 picks per quarter inch, 24's weft, at 8d per lb.? (20.) (O. 1892 C. G.)

For selvages 20 ends on each side are drawn in

double, so that takes off 20 ends from the width of the cloth. Therefore—

Reed = 60) 1940 (32·3 in. width in the reed.
180
140
120
200
180
20

Therefore—

32·3 in. width in reed.
80 picks per inch.
2584·0
50 yards cloth length.

840 × 24's = 20160) 129200 (6·4 lb., or 6 lb. 6½ oz., at
120960 8d per lb. = 4s 3¼d.
82400
80640
1760

Example—At what point of the shed do the healds cross in a 3-end twill (1 up) and a 4-end twill (1 up) where stocks and bowls are used? (15.) (O. 1892 C. G.)

Assuming that a 4 in. shed is formed in each case; then multiply depth of shed by the number of staves lifted, and divide by the number of staves in the set.

In the 3-end twill—

$$\frac{4 \times 1}{3} = 1{\cdot}3 \text{ in. from the bottom.}$$

In the 4-end twill—

$$\frac{4 \times 1}{4} = 1 \text{ in. from the bottom.}$$

Example—A loom has a pulley 9 inches diameter, and is driven by a drum of 15 inches diameter, running 108 revolutions per minute; how much cloth will the loom produce per week, the engine running 55 hours, and $\frac{1}{5}$ of time allowed for stoppages? There are 90 picks per inch in the cloth. (20.) (O. 1892 C. G.)

The engine runs 55 hours, less $\frac{1}{5}$.

$$\underline{11}$$

44 hours.

$$\text{Speed of loom} = \frac{15 \times 108}{9} = 180 \text{ picks per min.}$$

Therefore,

$$\frac{180 \times 44 \times 60}{90} = 5280 \text{ inches.}$$

$$5280 \div 36 = 146 \text{ yards } 24 \text{ inches.}$$

Example—A tappet has 180 teeth on, and runs 14 picks to the round; there is a 15's pinion on the loom shaft. Give the required intermediate wheels. (15.) (O. 1892 C. G.)

15 is the driver and 180 the driven wheels in the first case.

$$15 \times 14 = 210 = \text{intermediate driven.}$$

$$180 = \text{intermediate driver,}$$

or any ratio of these two numbers, say 18 and 21, or 36 and 42.

Example—Give full instructions to heald knitter for 5-end satin, 4 in a dent, 3-end twill, 2 in a dent, 60 reed Stockport counts, a pattern being on $1\frac{1}{2}$ in. $\frac{1}{3}$ satin, $\frac{2}{3}$ twill, half a twill stripe at each selvage, 36 inches in reed. (25.) (H. 1892 C. G.)

There are 24 complete patterns, and spaced healds are

knit in this order—$\frac{1}{2}$ in. satin on the first five staves; 1 in. twill on the other three staves, thus—

8
7
6
20 times through.
5
4
3
2
1
12 times through.

The first five staves will be knit 96's counts for half an inch, then miss one inch and knit again, in this order 24 times in all. The three back staves will be knit 80's counts for one inch, then miss half an inch and knit again in this order 20 times, in all; on each side of each of the three back staves $\frac{1}{2}$ of an inch is knit in the same way, so that they end at each side with half a twill stripe.

Example—What lift should a tappet have to make a plain cloth, the other arrangements in the loom being as follows:—Sweep of lay, $5\frac{1}{2}$ in.; distance of healds from fell of cloth, 8 in.; length of treadle, 24 in.; distance from heel of treadle to centre of treadle bowl, 16 in.; size of shuttle, $1\frac{1}{2}$ in. broad and $1\frac{1}{4}$ in. deep? (20.) (H. 1892 C. G.)

Allowing a quarter of an inch clearance for the shuttle.

Depth of shed at 4 in. from the fell of the cloth equals $1\frac{1}{2}$ in., at the healds 8 in. from the fell of the cloth it will equal $1\frac{1}{2} \times 8 \div 4 = 3$ in.

That is, the treadle at 24 in. from the end is depressed to that amount; the amount of depression at the treadle bowl 16 in. from the end $= 3 \times 16 \div 24 = 2$ in. stroke of tappet.

Example—What is the difference in the strain upon the yarn if you take off a tappet with a $\frac{1}{3}$ dwell and put on a tappet with $\frac{2}{3}$ dwell? (15.) (H. 1892 C. G.)

The strain varies just in proportion to the time of dwell; longer the dwell and greater the strain, so that a tappet with $\frac{2}{3}$ dwell will just put as much strain again on to the warp as the tappet with $\frac{1}{3}$ dwell. If the strain with $\frac{1}{3}$ dwell equals 1, the strain with $\frac{2}{3}$ dwell equals 2.

Example = You require a Granderelle thread to equal 10's counts, and have 60's red and 30's blue, what counts of white will be required to double with them? Also what will be the cost per lb. of the Granderelle if the 60's is 16d per lb., the 30's 14d per lb., and the white 10d per lb., and the cost of doubling 2d per lb.? (20.) (H. 1892 C. G.)

1st. Find resultant counts of 60's and 30's.

$$\frac{1000}{60} = 16{\cdot}6$$

$$\frac{1000}{30} = 33{\cdot}3$$

$$49{\cdot}9 \,)\, 1000 \,(\, 20\text{'s nearly.}$$

2nd. Find the counts to double with 20's to equal 10's.

$$\frac{1000}{10} = 100$$

$$\frac{1000}{20} = 50$$

$$\text{Difference} = 50 \,)\, 1000 \,(\, 20\text{'s.}$$

$$1000$$

Therefore 20's white, 30's blue, and 60's red twisted together equal 10's.

To find the cost per lb.—

60's red, 16d per lb.
30's blue, 14d „
20's white, 10d „

Find first the cost of 60's and 30's twisted together, thus—

60's at 14d = 840
30's at 16d = 480
90 1320

90) 1320 (14·6d.
90
420
360
600
540
60

Price per lb. of 60's and 30's, which equals 20's, 14·6d.

Find the price per lb. of 20's at 14·6d per lb., and 20's at 10d per lb., thus—

20's at 10d = 200
20's at 14·6 = 292
40 492

40) 492 (12·3d.
40
92
80
120
120

12·3d price per lb. of the Granderelle thread, with 2d added for doubling = 14·3d per lb.

Example—You have 42 lb. of 60's twist (take 5 per cent. off for working) to make a warp of 2080 ends, what length will it make? (15.) (O. 1893 C. G.)

42 lb. less 5 per cent. = 39·9 lb.

60 counts.

2394·0
840
957600
191520

Ends = 2080) 2010960·0 (967 yards nearly.
18720
13896
12480
14160
14560

Example—What is the counts of a 3-fold thread composed of 60's, 40's, and 24's? (15.) (O. 1893 C. G.)

$\frac{1000}{60} = 16{\cdot}6$

$\frac{1000}{40} = 25{\cdot}0$

$\frac{1000}{24} = 41{\cdot}6$

83·2) 10000 (12's counts.
832
1680
1664
16

Example—Give net grey cost per yard of a shirting woven in an 80 reed Stockport, 36's warp 20 picks per quarter inch, 30's weft, to be 40 inches grey upon the table. Price of warp, $11\frac{1}{4}$d per lb. in the loom; weft

$7\frac{3}{4}$d ; weaving, 3s 4d per 100 yards, and expenses same as weaving. (25.) (O. 1893 C. G.)

Add 6 per cent. to width of cloth to obtain the width in the reed. Add 6 per cent. to cloth length to obtain tapers length.

Therefore, weight of warp equals—

40 in. width + 6 per cent. = 42·4 in. width in the reed.

80 reed used.

3392·0

100 yds. length + 6 per cent. = 106 yds. tapers length.

203520

339200

840 × 36's = 30240) 359552·0 (11·89 lb. nearly.

30240

57152

30240

269120

241920

272000

272160

Weight of weft—

42·4 in. width in the reed.

80 picks per inch.

3392·0

100 cloth length.

840 × 30's = 25200) 339200·0 (13·46 lb.

25200

87200

75600

116000

100800

152000

151200

800

Cost—

Warp, 11·89 lb. at	$11\frac{1}{4}$d	= 133·76	pence.
Weft, 13·46 lb. at	$7\frac{3}{4}$d	= 104·30	„
Weaving,	-	= 40·00	„
Expenses,	-	= 40·00	„
		318·06	price per 100 yds.

$318 \div 100 = 3{\cdot}18$d price for one yard.

Example—Give range of taking-up wheels and size of roller for 24 picks to quarter inch. (20.) (O. 1893 C.G.)

Pickles' taking-up motion could be given here; but we will assume that the student at the time does not remember a set of wheels.

Then, picks per quarter inch multiplied by change wheel equals dividend, and the dividend multiplied by the pinion and circumference of beam in quarter inches; equals rack, stud, and beam wheels, multiplied together. Therefore, assume a change wheel of 20 teeth, then

$$\frac{\text{Rack. } 60 \times \text{Beam. } 90 \times \text{Stud. } 80}{60 \times 15 \times 24 \times 20} = 0$$

Cir. of Beam. Pinion. Picks. Change Wheel.

This train of wheels will give 24 picks per $\frac{1}{4}$ inch in the loom, $1\frac{1}{2}$ per cent. more picks out of the loom.

Example—The main shaft of a weaving shed runs 100 revolutions per minute, and carries a wheel of 50 teeth, which drives another wheel of 49 teeth on line shaft a drum of 14 inches upon this shaft drives a loom pulley of 9 inches; how many picks per minute does the loom run? (25.) (O. 1893 C. G.)

The drivers are—100 rev. 50 wheel and 14 in drum.

The driven are—49 wheel and 9 in. pulley.

The speed of a driven is required.

Therefore multiply all the drivers together and divide by the driven, thus—

$$\frac{100 \times 50 \times 14}{49 \times 9} = 158{\cdot}7 \text{ rev. per minute.}$$

Example—In two looms running at the same speed and alike in every other particular, but one having a 6 in. sweep and the other a $7\frac{1}{2}$ in. sweep, what is the relative force of the respective lays? (H. 1893 C. G.)

$$6^2 = 36$$
$$7\tfrac{1}{2}^2 = 56{\cdot}2$$

Taking the force in the 6 in. crank to equal 1, the force of the $7\frac{1}{2}$ in. crank will equal

$$\begin{array}{r} 36 \,)\, 56{\cdot}2 \,(\, 1{\cdot}5 \\ 36{\cdot} \\ \hline 202 \\ 180 \\ \hline 22 \end{array}$$

Example—For a side tappet loom, give the length of the top lever at each side of fulcrum, the other particulars being—Lift of tappet, $2\frac{1}{2}$ in.; from heel of treadle to tappet bowl, 20 in.; total length of treadle, 30 in.; shuttle, 2 in. wide $1\frac{1}{2}$ in deep; sweep of lay, 6 in.; the front of healds 9 in. from fell of cloth. (25.) (H. 1893 C.G.)

Allowing half an inch clearance for the shuttle, the depth of the shed at 4 in. from the fell of the cloth equals 2 in. at the healds, 9 in. from the fell of the cloth it $= 2 \times 9 \div 4 = 4{\cdot}5$ in.

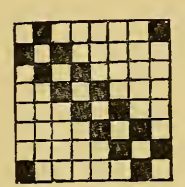
The treadle is depressed $2\frac{1}{2}$ in. by the action of the tappet at 20 in. from the end; at 30 in. from the end the treadle is depressed $2\frac{1}{2} \times 30 \div 20 = 3{\cdot}75$ in.

The length of arms on the top lever are therefore—4·5 in. on that side to which the healds are attached,

and 3·75 in. on the other side, or any ratio of these two numbers.

Example—I have a piece of cloth woven with pattern marked A, containing 60 ends 16's twist, 60 picks 16's weft per inch, and wishing to weave a heavier cloth of similar firmness I select pattern B. How many ends and picks per inch shall I require to use the same materials? Also what counts shall I require for pattern B to have 60 ends and 60 picks? (25.) (H. 1893 C. G.)

FIG. 14.



A

B

Pattern A contains—

8 threads + 4 intersection = 12.

Pattern B contains—

8 threads + 2 intersection = 10.

Therefore,

$$\begin{array}{r} 60 \\ 12 \\ \hline 10\,)\,720 \\ \hline 72 \end{array}$$

72 threads and picks per in. required.

If the same threads and picks are used to find counts $\sqrt{16} = 4$, therefore,

$$\begin{array}{r} 4 \\ 10 \\ \hline 12\,)\,40 \\ \hline 3{\cdot}3 \end{array}$$

$3{\cdot}3^2 = 10{\cdot}89$'s counts.

Example—If one lea of yarn be wrapped from each of four cops, and the total wrappings are found to weigh 4 dwt. 8 grs., what counts is the yarn? (15.) (O. 1894 C. G.)

Weight of yarn in grains = Grs. 4 Dwt. 8

24

104 grs.

Therefore, $4000 \div 104 = 38{\cdot}4$'s counts.

Example—What percentage of size will be put on the warp yarn to make a piece of cloth to the following particulars:—36 inches wide, 38 yards long on the counter, 57's reed (Stockport counts), 14 picks per quarter inch, 32's twist, 34's weft, piece to weigh $8\frac{1}{4}$ lb.? (35.) (O. 1894 C. G.)

Weight of warp yarn—

Add 6 per cent. to cloth width = 38·16 in. width in reed.

57 reed used.

26712

19080

2175·12

Add 6 per cent. to cloth length = 40·28 yds. tapers length

1740096

435024

8700480

$840 \times 32 = 26880$) 87613·8336 (3·25, nearly

80640 3·26 lb.

69738

53760

159783

134400

25383

Weight of weft—38·16 in. width in reed.
56 picks per inch.

22896
19080

2136·96
38 yards cloth length.

1709568
641088

840 × 34 = 28560) 81204·48 (2·84 lb.
57120

240844
228480

123648
114240

9408

Weight of warp = 3·26 lb.
Weight of weft = 2·84 lb.

6·10 total weight of yarn.

The piece weighs $8\frac{1}{4}$ or 8·25 lb., therefore,

8·25
6·10

2·15 lb. weight of size.

To find the percentage, add two cyphers to the weight of size and divide by the weight of yarn sized, namely, the weight of the warp.

3·26) 215·00 (65·95 per cent. of size.
1956

1940
1630

3100
2934

1660
1630

30

Example—Work out the weight of twist and weft required to make a piece to the following particulars :—42 inches wide, 80 yards long on the counter, 96's reed (Stockport counts), 24 picks per quarter inch, 60's twist, 64's weft. What is the cost of the piece with twist at 10½d per lb., weft at 9d, the price paid for weaving being 3s 7d, and other expenses adding up to 3s 3½d? (40.) (O. 1894 C. G.)

Weight of warp—

Add 6 per cent. to width of cloth = 44·5 in. width in reed.

96 reed.

2670
4005
4272·0

Add 6 per cent. to cloth length = 84·8 yds. tapers length.

34176
17088
34176

840 × 60's = 50400) 362265·6 (7·18 lb. weight of warp.

352800

94656
50400
442560
403200
39360

Weight of weft—

44·5 width of reed.
96 picks per inch.

2670
4005
4272·0

80 yards cloth length.

341760

$840 \times 64\text{'s} = 53760 \;)\; 341760 \;(\; 6{\cdot}35$ lb. weight of weft.

322560

192000

161280

307200

268800

38400

Cost—		s.	d.
Warp, 7·18 lb. at $10\frac{1}{2}$d per lb.	=	6	$3\frac{1}{4}$
Weft, 6·35 lb. at 9d „	=	4	9
Weaving, - -	=	3	7
Expenses, - -	=	3	$3\frac{1}{2}$
		17	$10\frac{3}{4}$

Example—What is the cost of the following cloth :—50 inches wide, 120 yards long on the counter, containing 60 ends of 60's twist, and 40 ends of 28's twist per inch, and 18 picks of 60's weft to the quarter inch ; Twist—60's at $10\frac{1}{2}$d per lb., 28's at $6\frac{3}{4}$d per lb. ; weft—60's at $8\frac{3}{4}$d per lb. ; weaving, 4s 9d ; expenses, 5s 3d? (35.) (O. 1894 C. G.)

The number of ends in the warp of 60's is—

60 times width of cloth = 3000

Add 6 per cent. to cloth length, 127·2 yds. tapers length

6000

21000

6000

3000

$840 \times 60 \times 50400 \;)\; 381600{\cdot}0 \;)\; 7{\cdot}57$ lb. weight of 60's warp.

352800

288000

252000

360000

352800

7200

The number of ends in the warp of 28's =
40 times width of cloth = 2000 ends.

127·2 tapers length.
4000
14000
4000
2000

840 × 28 = 23520) 254400·0 (10·81 lb. weight
23520 of 28's warp.
192000
188160
38400
23520
14880

Weight of weft—
Add 6 per cent. to width of cloth = 53 in. width in reed.

72 picks per inch.
106
371
3816
120 yds. cloth length.

840 × 60 = 50400) 457920 (9·08 lbs. weight
453600 of weft.
432000
403200
28800

Cost—		s.	d.
Warp, 7·57 lb. 60's at $10\frac{1}{2}$d per lb. =		6	$7\frac{1}{2}$
Warp, 10·81 lb. 28's at $6\frac{3}{4}$d „		6	1
Weft, 9·08 lb. 60's at $8\frac{3}{4}$d „		6	$7\frac{1}{2}$
Weaving, - - -		4	9
Expenses, - - -		5	3
Total cost,	£1	9	4

Perhaps a different construction can be placed on this question, and taken to mean that 60 ends of 60's occupy one inch, and also 40 ends of 28's to occupy one inch, or the two stripes together standing on two inches. In working out the example it has been assumed that 60 ends of 60's and 40 ends of 28's taken together occupy one inch of the reed.

Example—A piece of cloth, 38 inches wide and 38 yards long on the counter, containing 62 ends and 58 picks per inch, weighs 9 lbs. On being analyzed it is proved to be one-third size, and the warp and weft threads are found to be similar counts. What is the counts of the yarn? (30.) (O. 1894 C. G.)

One-third of the weight is size, therefore the weight of yarn in the piece equals 6 lb. Find first the weight of warp and weft separately in the piece.

The threads and picks added together equal

$$62 + 58 = 120$$

Divide the weight 6 lb. into 120 parts, then take 62 parts for the weight of warp and 58 parts for the weight of weft, thus—

$$120 \overline{)\ 6{\cdot}00 \text{ lb.}} \ (\ {\cdot}05 \text{ lb.}$$
$$\underline{600}$$
$$62 \times {\cdot}05 = \text{weight of warp} = 3{\cdot}1 \text{ lb.}$$
$$58 \times {\cdot}05 = \text{weight of weft} = 2{\cdot}9 \text{ lb.}$$
$$\text{Total weight, } \underline{6{\cdot}0}$$

To find the counts of warp—

$$\frac{\overset{\text{Width of Cloth.}}{38} \times \overset{\text{Threads per in.}}{62} \times \overset{\text{Length.}}{40{\cdot}28}}{\underset{\text{Weight.}}{840 \times 3{\cdot}1}} = 36{\cdot}44\text{'s}$$

Counts of weft—

$$\frac{\overset{\text{Width of Cloth.}}{40{\cdot}28} \times \overset{\text{Picks per in.}}{58} \times \overset{\text{Length.}}{38}}{\underset{\text{Weight.}}{840 \times 2{\cdot}9}} = 36{\cdot}44\text{'s}$$

Proof—

In the warp 6 per cent. is added to the cloth length; and in the weft 6 per cent. is added to the width.

$$\frac{38 \times 62 \times 40{\cdot}28}{840 \times 36{\cdot}44} = 3{\cdot}1 \text{ lb. weight of warp.}$$

$$\frac{40{\cdot}28 \times 58 \times 38}{840 \times 36{\cdot}44} = 2{\cdot}9 \text{ lb. weight of weft.}$$

Example—A cloth is made 30 inches wide, 100 yards long, 25's warp yarn, and 50's weft; the threads and picks per inch are equal; the total weight of the piece is 13·62 lb. Find the threads and picks per inch. Allow 6 per cent. for length and 6 per cent. for width. The weights of warp and weft will be in inverse proportion to the counts of yarn, that is, as two to one. Therefore, dividing 13·62 into three equal parts, thus—13·62 ÷ 3 = 4·54 lb., which equals weight of weft. The warp weighs 4·54 lb. × 2 = 9·08 lb.

Therefore to find the threads per inch—

$$\frac{\overset{\text{Counts.}}{840} \times \overset{\text{Weight.}}{25} \times 9{\cdot}08}{\underset{\text{Length.}}{106} \times \underset{\text{Width.}}{30}} = 60 \text{ threads per inch.}$$

Picks per inch—

$$\frac{\overset{\text{Counts.}}{840} \times \overset{\text{Weight.}}{50} \times 4{\cdot}54}{\underset{\text{Length.}}{100} \times \underset{\text{Width.}}{31{\cdot}8}} = 60 \text{ picks per inch.}$$

Proof—

$$\frac{30 \times 106 \times 60}{840 \times 25} = 9{\cdot}08 \text{ lb. weight of warp.}$$

$$\frac{31{\cdot}8 \times 100 \times 60}{840 \times 50} = 4{\cdot}54 \text{ weight of weft.}$$

Example—What is the cost of the piece of cloth named below ?

28 inches wide, 50 yards long, 82's reed (Stockport counts), 24 picks per quarter inch, made from 2/40's twist at 11d per lb., and 20's weft at 7d per lb. ; weaving, 4s ; expenses, 4s 3d. (30.) (H. 1894 C. G.)

Weight of warp—

Add 6 per cent. to width of cloth = 29·68 in. width in reed.

```
                 82 reed
               5936
              23744
             2433·76
```

Add 6 per cent. to cloth length = 53 yds. tapers length

```
                730128
2/40's = 20's  1216880
840 × 20 = 16800 ) 128989·28 ( 7·67 lb.
                   117600
                   113892
                   100800
                   130920
                   117600
                    13320
```

Weight of weft—

```
                29·68 in. width in reed.
                   96 picks per inch.
                17808
               26712
              2849·28
                   50 yds. cloth length.
840 × 20 = 16800 ) 142464·00 ( 8·48 lb.
                   134400
                    80640
                    67200
                   134400
                   134400
```

			s.	d.
Warp, 7·67 lb. at 11d per lb.	=		7	$0\frac{1}{4}$
Weft, 8·48 lb. at 7d ,,	=		4	$11\frac{1}{4}$
Weaving, - -			4	0
Expenses, - -			4	3
Total cost,	=	£1	0	$2\frac{1}{2}$

Example—What is the cost of the undermentioned piece of cloth?

40 inches wide, 120 yards long, 80's reed (Stockport counts), 21 picks per quarter inch, made from 50's twist at $9\frac{1}{2}$d per lb., and 50's weft at 8d per lb.; weaving, 4s 2d; expenses according to your own estimate, showing how you estimate the expenses for each department and for standing charges. (35.) (H. 1894 C. G.)

Weight of warp—

Add 6 per cent to width of cloth = 42·4 in. width in reed.

80 reed

3392·0

Add 6 per cent. to cloth length = 127·2 tapers length

6784

23744

6784

3392

840 × 50 = 42000) 431462·4 (10·27 lb.

42000

114624

84000

306240

294000

12240

Weight of weft—

42·4 in. width in reed.

84 picks per inch.

1696

3392

3561·6

120 yds. cloth length.

427392·0

$840 \times 50 = 42000$) 427392·0 (10·17 lb.
42000
73920
42000
319200
294000
25200

Cost—		S.	D.
Warp, 10·27 lb. at 9½d per lb. - - =		8	1½
Weft, 10·17 lb. at 8d „ - - =		6	9¼
Weaving, - - - - -		4	2
Taping, Winding, and Beaming, 20% on weaving,		–	10
Twisting, - - - 3%		–	1½
Overlookers, Warehousemen, and Managers, 18%		–	9
Standing Charges for Stores, Interest on Capital, and Depreciation, 40%		1	8
	£1	2	5¼

Example—If the diameter of a 60's thread is $\frac{1}{202}$ in., what is the diameter of a 30's? (5.) (1894 L. and C.)

Square root of 60 = 7·74
Square root of 30 = 5·47

Therefore,
202
5·47
1414
808
1010
7·74) 1104·94 (142·75
774
3309
3096
2134
1548
5860
5418
4420
3870
550

Diameter of 30's =
1
$142\frac{3}{4}$

Example—Find the cost of twist and weft in a piece of cloth on counter 34 inches wide, 78 yards long, 18 × 18 per quarter inch, 40's twist at 8d per lb., 36's weft at 7½d per lb.; weaving, 2s 6d; expenses same as weaving. (12.) (O. 1894 L. and C.)

Weight of warp—

34 in. width of cloth.
72 threads per inch.
68
238
2448

Add 6 per cent. to cloth length = 82·68 tapers length.

19584
14688
4896
19584

840 × 40 = 33600) 202400·64 (6·02 lb. weight of warp.
201600
80064
67200
12864

Weight of weft—

Add 6 per cent. to cloth width = 36 in. width in reed.
72 picks per inch.
72
252
2592
78 yds. cloth length.
20736
18144

840 × 36 = 30240) 202176 (6·68 lb.
181440
207360
181440
259200
241920
17280

Cost—	s.	d.
Warp, 6·02 lb., at 8d per lb. =	4	0
Weft, 6·68 lb., at $7\frac{1}{2}$ per lb. =	4	2
Weaving and expenses, -	5	0
	13	2 cost of piece.

Example—Find the dividend of the following taking-up motion:—50 rack wheel, 120 stud wheel, 15 pinion, 75 beam wheel, circumference of emery beam 15 inches. (10.) (O. 1894 L. and C.)

$$\frac{50 \times 120 \times 75}{15 \times 60} = 500$$

Add $1\frac{1}{2}$ per cent. for contraction, therefore,

$$500 + 7 = 507 \text{ dividend.}$$

Example—What is the resultant counts of a 10's, 30's, and 40's thread twisted together? (6.) (O. 1894 L. and C.)

$$\frac{1000}{10} = 100$$

$$\frac{1000}{30} = 33{\cdot}3$$

$$\frac{1000}{40} = 25{\cdot}$$

$$158{\cdot}3 \;)\; 10000 \;(\; 6{\cdot}3\text{'s counts.}$$

$$\begin{array}{r} 9498 \\ \hline 5020 \\ 4749 \\ \hline 271 \end{array}$$

Example—A warp is sized to the extent of 60 per cent., and is then found to weigh 98 lbs.; it contains 2056 ends, 32's counts. What is the length?

1st. Find the weight of the warp before sizing—

98 lb.
60

160) 5880 (36·75 weight of size.
480
1080
960
1200
1120
800
800

98 lb. less 36·75 lb. weight of size equals 61¼ lb., weight of yarn before sizing.

2nd. Find the length—

840
61¼ weight.
840
5040
210
51450
32 counts.
102900
154350

Ends 2056) 1646400 (800·7 yards.
16448
16000
14392
1608

LANCASHIRE AND CHESHIRE EXAMINATION PAPER, 1895.

Q. 13. Calculate the cost of a piece of plain cloth 54 inches wide, 58 yards long, 70 ends, and 64 picks tc the inch, all actual dimensions; 36's warp twist at 6d per lb., 54's weft at 7d per lb.; weavers' wages, 20d, and allowances for other expenses, 19d. In making the

calculation, show the hanks and weight of both warp and weft, and give reasons for any allowances you would make. (20.) (1895 L. and C.)

The allowances to be made in the warp will be 6 per cent. added to cloth length to obtain tapers length.

58 yds. + 6 per cent. = 61·48 yds.

54 in. width of cloth.
70 threads per inch.
3780
61·48 tapers length.

840 | 30240
36 | 15120
5040 | 3780
2520 | 22680
30240) 232394·40 (7·68 lb. weight of warp,
211680 or
207144 | 7·68
181440 | 36
257040 | 4608
241920 | 2304
15120 | 276·48 hanks

The calculation for the weft is taken on the width in the reed. To obtain this 6 per cent. is added to the cloth width, therefore—

54 + 6 per cent. = 57·24 in. width in reed.

57·24 in. width in reed.
64 picks per inch.
22896
34344
3663·36
58 yards cloth length.

840 | 2930688
54 | 1831680
3360 | 212474·88
4200
45360)

45360) 212474·88 (4·68 lb. weight of weft,
181440 or
310348 4·68
272160 54
381880 1872
362880 2340
19000 252·72 hanks.

Add 4 per cent. to weft to allow for waste; weight of weft therefore equals 4·86 lb.

Cost—		s.	d.
	Warp, 7·68 lb. at 6d per lb. =	3	10
	Weft, 4·86 lb. at 7d „	2	10
	Weaving, - -	1	8
	Expenses, - -	1	7
		9	11

Q. 14. Write out the table of weights by which the counts of cotton yarn are determined. If 264 yards of yarn weighs 1 dwt. $3\frac{1}{2}$ grs., what are the counts? (15.) (1895 L. and C.)

TABLE OF WEIGHTS.

24 grs. = 1 dwt.
$437\frac{1}{2}$ grs. = 1 oz.
7000 grs. or 16 oz. = 1 lb.

The weight of the sample = $27\frac{1}{2}$ grs.
To find the counts—

$$\frac{7000 \times 264}{840 \times 27\frac{1}{2}} = \text{counts}$$

Therefore 840
$27\frac{1}{2}$
5880
1680
420
23100) 1848000 (80's counts.
184800
0

Q. 15. Give the train of wheels, naming each, in any

well-known take-up motion required to give 24 picks to the quarter as nearly as possible. Make a calculation showing that the wheels you give are correct, and give the dividend of the combination. (15.) (1895 L. and C.)

Pickles' take-up motion; circumference of beam, 60·2 quarter inches; beam wheel, 90; stud wheel, 89; rack wheel, 24; pinion, 15; swing pinion, 24; and one of the change wheels, 36 teeth; the number of teeth in the other change wheel equals the number of picks per inch in the cloth counted on the counter, namely, 96.

The dividend of a taking-up motion is a number which if used for a change wheel will give one pick per quarter inch, therefore,

$$\frac{36 \times 24 \times 15 \times 60{\cdot}2}{89 \times 90 \times 24} = 4{\cdot}06$$

4·06, less $1\frac{1}{2}$ per cent. for contraction $= 4 \times 1\frac{1}{2} \div 100 =$ ·06; therefore, 4·06 − ·06 = 4. A wheel of 4 teeth gives 4 picks per inch, a wheel of 96 teeth gives 96 picks per inch, or 24 picks per quarter inch out of loom.

Q. 16. If the price for weaving a piece of cloth according to the uniform list is 25s 6d, subject to the following:— An addition of 3 per cent. for pick, of $4\frac{1}{2}$ per cent. for weft, and the current deduction of 10 per cent., what will be the price payable to the weaver, all allowances to be made in the order named? (10.) (1895 L. and C.)

Price in Pence:

S.	D.	
25	6	
12		
306		pence.
		9·18 = 3 per cent. on for pick.
315·18		
		14·18 = $4\frac{1}{2}$ per cent. on for weft.
329·36		
		32·93 = 10 per cent. off list price.
296·43		pence.

12) 296·4

24·8$\frac{1}{2}$ Price, £1 4s 8$\frac{1}{2}$d.

Q. 17. A sett of 7 beams 2400 ends each, and each containing 23 forty-yard cuts, weighs 920 lb. in all, what are the average counts? (10.) (1895 L. and C.)

$$\frac{7 \times 2400 \times 23 \times 40}{840 \times 920} = 20\text{'s counts.}$$

Or, 7 beams weigh 920 lb., therefore one beam weighs

$$7 \overline{)\,920}$$

$$131{\cdot}43 \text{ lb. nearly.}$$

Therefore, ends multiplied by length, divided by 840 times weight, gives counts.

2400 ends.
920 yards length.
48000
21600

$840 \times 131{\cdot}43 = 110400 \overline{)\,2208000}$ (20's counts.
220800

Q. 18. A check cloth has a pattern in both warp and weft as under:—

2 Red.
8 Brown.
2 Sky.
4 Brown.
2 Sky.
4 Brown.
2 Sky.
8 Brown.

Give the number of hanks and weight of each kind of yarn required for 20 pieces, 32 in., 80 yards, 48 reed, Stockport counts, 13 picks to quarter inch, 20's warp, and 16's weft. (20.) (1895 L. and C.)

The cloth is 32 inches wide, the width in the reed will be 6 per cent. wider, therefore width in reed = 33·9

inches ; the cloth length is 80 yards, therefore the tapers length will be about 6 per cent. more, therefore tapers length = 84·8 yards.

The number of ends in the warp =

33·9 width in reed.
48 reed used.
271·2
1356
1627·2 ends in warp.

There are 32 coloured ends in each pattern, therefore 1627 ÷ 32 gives nearly 51 complete patterns.

In each pattern there are the following ends :—

Red.	Brown.	Sky.
2	24	6

Multiplying each of these by 51 it gives—

Red.	Brown.	Sky.
102	1224	306

The number of hanks of each colour of warp are :—

Red—

102 ends.
84·8 tapers length.
816
840 408
20 816
16800) 8649·6 (·5148 lb. weight,
84000
24960
16800
81600
67200
144000
134400
9600

or

·5148
20
10·2960 hanks.

Brown—There are 24 brown to 2 red ends, therefore weight of brown warp equals :—

·5148		6·1776
12	or	20
6·1776 lb.		123·5520 hanks.

Sky—There are 6 sky to 2 red, therefore the weight of sky equals :—

·5148		1·5444
3	or	20
1·5444 lb.		30·8880 hanks.

The weight of the weft in the piece, assuming that it is all one colour, will equal—

33·9 inches width in reed.
52 picks per inch.

840	678
16	1695
5040	1762·8
840	80 yards cloth length.
13440)	141024·0 (10·49 lb. weight.
	13440
	66240
	53760
	124800
	120960
	3840

There are 32 picks in one repeat of the pattern, of

which 2 picks are red, therefore $\frac{1}{16}$ of the total weight of weft will be red.

16) 10·49 (·655 lb. weight of red weft,

9 6	or
89	·655
80	16
90	3930
80	655
10	10·480 hanks.

There are 24 brown picks to 2 red picks, therefore weight of brown weft equals :—

·655		7·860
12	or	16
7·860 lb.		47160
		7860
		125·760 hanks.

There are 6 sky picks to 2 red picks, therefore weight of sky weft equals :—

·655		1·965
3	or	16
1·965 lb.		11790
		1965
		31·440 hanks.

The respective weights and hanks for 20 pieces are :—

Warp—

	Lbs.	Pcs.	Lbs.	Hanks.	Pcs.	Hanks.
Red, weight—	·5148	× 20 =	10·296 ;	10·296	× 20 =	205·9
Brown, „	6·17	× 20 =	123·4 ;	123·4	× 20 =	2468
Sky, „	1·54	× 20 =	30·85 ;	30·85	× 20 =	617

Weft—

	Lbs.	Pcs.	Lbs.	Hanks.	Pcs.	Hanks.
Red, weight—	·655	× 20 =	13·1 ;	10·48	× 20 =	209·6
Brown, „	7·86	× 20 =	157·2 ;	125·76	× 20 =	2515·2
Sky, „	1·965	× 20 =	39·3 ;	31·44	× 20 =	628·8

Q. 19. A thread is made up of 1 of each of 10's, 12's, and 15's folded together. What are the counts of the 3-fold thread? (10.) (1895 L. and C.)

$$\frac{1000}{10} = \text{Grs. } 100$$

$$\frac{1000}{12} = 83{\cdot}3$$

$$\frac{1000}{15} = 66{\cdot}6$$

$249{\cdot}9$ say total weight = 250 grains.

$1000 \div 250 = 4$'s counts.

Q. 20. What wheels—tin roller wheel and stud wheel—will be required to mark a cut every 39 yds. 8 in. on an ordinary slasher or tape frame? (10.) (1895 L. and C.)

Length of mark in inches—

39 yds. 8 in.
36
242
117
1412 gives stud wheel.

Circumference of measuring roller, 14·4 in., and bell wheel, 45 teeth, multiplied together give 648, which will equal tin roller wheel, or

1412 stud wheel.
648 tin roller wheel.

When these numbers are too large for practical purposes, any ratio of the two numbers will do, namely :—

```
648 ) 1412 ( 2·18 nearly.
      1296
      ----
       1160
        648
        ---
        5120
        5184
```

As 1 tin roller wheel is to 2·18 stud wheel ; multiply them both by 50 = 50 tin roller wheel, 109 = stud wheel.

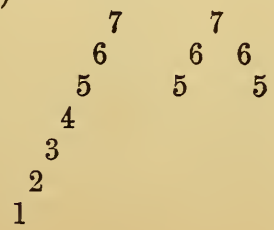
These wheels give 39 yds. $8\frac{1}{2}$ ins.

Q. 21. A 600 (612) Jacquard is used for cloth made in a 120 reed. How many hooks would be cast out and in what manner if a 110 reed were to be used? (10.) (1895 L. and C.)

Using a 110 reed instead of 120, 10 hooks will be dropped out of every 120 hooks, or 50 hooks out of the 600 in the machine.

Assuming that there are 12 hooks in a row, 4 rows and 2 hooks will be cast out, say the 10th, 20th, 30th, and 40th, and the bottom 2 needles on the 51st row.

Q. 22. Give the number of reed in any system now in use with which you are best acquainted that gives the same result as a 60 reed Stockport. Give the counts of spaced healds required to work with a 60 Stockport reed, 2 ends in a dent, to enable the following 12 end draft to be made, leaving no empty heald eyes. (20.) (1895 L. and C.)



In converting the counts of reed from one system to another, find the dents per inch in each system. Say we convert the 60 reed Stockport to Bolton reed, which is based on the number of beers on $24\frac{1}{4}$ inches.

The number of dents per inch for 1's counts in Stockport = ·5.

The number of dents per inch in Bolton counts equals—

20 dents comprise a beer, therefore 20 divided by $24\frac{1}{4}$ will give the dents per inch.

```
24·25 ) 20000 ( ·8247
        19400
        ------
         6000
         4850
         ----
        11500
         9700
         ----
        18000
        16975
        -----
         1025
```

Therefore,

```
          60
          ·5
        -----
·8247 ) 30·0000 ( 36·3, nearly 36·4's.
        24741
        -----
         52590
         49482
         -----
         31080
         24741
         -----
          6339
```

The second part of the question gives counts of healds, &c.

There are 12 ends in the pattern, therefore the number of complete patterns on one inch equals $60 \div 12 = 5$.

On staves 1, 2, 3, 4, five stitches per inch are knit, and as 4 healds are considered a set, stitches per inch multiplied by 4 gives counts of healds, namely, $5 \times 4 = 20$ counts for the staves 1, 2, 3, 4; on staves 5 and 6 there are 15 stitches per inch, therefore $15 \times 4 = 60$'s counts for staves 5 and 6; on stave 7 there are 10 stitches per inch, therefore $10 \times 4 = 40$'s counts for stave number 7.

Q. 23. If a plain loom makes 160 picks per minute, and is driven through a $10\frac{1}{2}$ inch pulley on crank shaft, what size of pulley would have to be placed there in order to run the loom 140 picks per minute? (10.) (1895 L. and C.)

A $10\frac{1}{2}$ inch pulley drives the loom 160 picks per minute. The loom is required to run slower; will a larger or a smaller pulley be required? A larger; therefore—

$10\frac{1}{2}$ or 10·5 size of pulley.
160 greater speed.
6300
105
Lesser speed 140) 1680·0 (12 inch pulley required.
140
280
280

Q. 24. How much would be paid to a warper for making 17 warps—10 warps 24's, 700 yards long, and 800 ends each; and 7 warps 30's, 900 ends, and 700 yards each, both at $6\frac{3}{8}$d per 1000 hanks? (10.) (1895 L. and C.)

Find the number of hanks in each lot. The formula for so doing is—

Ends × length ÷ 840.

Therefore the number of hanks in the 10 warps equals—

800 ends.
700 yards length.
560000
10 warps.

840) 5600000 (6666·66 hanks, nearly 6666·7
5040
5600
5040
5600
5040
5600
5040
5600
5040
560

The number of hanks in the 7 warps equals—

900 ends.
700 yards.
630000
7 warps.

840) 4410000 (5250 hanks.
4200
2100
1680
4200
4200

Total number of hanks equals 6666·7 + 5250.

5250·0
11916·7

At $6\frac{3}{8}$d per 1000 hanks, multiply the total hanks and price together and divide by 1000.

11916 hanks.
$6\frac{3}{8}$
71496
4467 = $\frac{3}{8}$
1000) 75·963 (75·963 pence, or nearly 6s 4d.

City and Guilds of London Institutes Examination Questions 1895—Ordinary Grade.

Q. 1. Four cops of twist weighing $6\frac{1}{2}$ oz. are found on being wrapped to be 60's. What length of yarn will they contain? (12 marks.) (O. 1895 C. G.)

16 oz. or 1 lb. of 60's contains 60 hanks, or 60 × 840 yards.

840
60
50400 yds. in 16 oz.

In $6\frac{1}{2}$ oz. there will be less length, therefore—

50400
$6\frac{1}{2}$
302400
25200
16) 327600 (20475 yds. length of $6\frac{1}{2}$ oz.
32
76
64
120
112
80
80

Or

$$\frac{840 \times \text{counts} \times \text{weight in grs.}}{7000} = \text{Length.}$$

Q. 2. Describe the measuring and self-stopping motions of a beam warping machine. Sketch the parts. (20.) (O. 1895 C. G.)

The measuring motion consists of a measuring roller 18 inches in circumference, over which the yarn passes and carries it round. On the end of the measuring roller is a worm driving a wheel of 70 teeth, on the same stud as the wheel of 70 teeth is another worm driving a wheel of 100 teeth—this last wheel is termed the wrap wheel, and when it has made one complete revolution 3500 yards have passed the measuring roller, thus—

$$\frac{18 \times 70 \times 100}{36 \text{ in. to the yard}} = 3500 \text{ yards.}$$

Q. 3. You are required to prepare a set of warpers beams for the following order :—200 pieces, 38 inches wide, 50 yards long, 32's twist, 78's reed, cloth to contain 23 picks of 38's weft per quarter inch. What number of beams will you warp, and of what length ? What weight of twist ought there to be on each beam ? (25.) (O. 1895 C. G.)

Find first the weight of warp in one piece. Add 6 per cent. to width of cloth to obtain width in reed. Add 6 per cent. to cloth length to obtain tapers length.

38 inches + 6 per cent. = 40·28 inches.
50 yards + 6 „ = 53 yards.

Therefore—

40·28 width in reed.
78 reed used.

32224
28196

840 | 3141·84 ends.
32 | 53 yards tapers length

1680 | 942552
2520 | 1570920

26880) 166517·52 (6·194 lb. weight of warp
161280· in one piece.

52375
26880

254950
241920

130300
107520

22780

Ends in the set, 3141, made up from seven back beams of 400 ends each, and one back beam of 341 ends = 2800 + 341 = 3141 ends.

The length of yarn for one piece equals 53 yards; the length of yarn on each back beam = 200 × 53 = 10600 yards.

The weight of one piece = 6·194 lb., the weight of 200 pieces = 200 × 6·194 = 1238·8 lb., which is the weight of yarn on the warper's beams.

Q. 4. What is meant by a 74's reed (Stockport

counts)? A cloth made with 3420 ends is dented as follows, the whole width in the reed being $40\frac{2}{3}$ inches :—

10	dents,	2 = 20	ends	- - -	20
20	„	1 = 20	„		
6	„	2 = 12	„		
1	„	0 = 0	„	60 times =	3360
6	„	2 = 12	„		
1	„	0 = 0	„		
6	„	2 = 12	„		
20	„	1 = 20	„	- - -	20
10	„	2 = 20	„	- - -	20
					3420 ends.

What counts of reed will be used? (25.) (O. 1895 C. and G.)

The Stockport counts of reed is based on the number of dents on two inches, therefore a 74 Stockport reed means a reed with 74 dents on two inches, or 37 dents per inch.

The second part of the question is answered thus :— There are 10 dents on one side, and 30 dents on the other side of the reed, added together equals 40 dents. One repeat of the pattern gives :—

6	dents.
1	„
6	„
1	„
6	„
20	„
40	dents.

40 dents 60 times repeated equals 2400 dents, plus the 40 dents at the sides equals 2440 dents, which occupy a

space of $40\frac{2}{3}$ inches; the number of dents per inch = $2440 \div 40\frac{2}{3} = 60$. Assuming that a Stockport reed is used, the counts will be $60 \times 2 = 120$ reed.

Q. 8. With a 15 crank wheel and a 200 tappet wheel, what intermediate wheels would you use for 16 picks to the round? (12.) (O. 1895 C. G.)

$15 \times 16 = 240$ the driven intermediate.
200 the intermediate driver.

Or any ratio of these two numbers, divide them both by 10.

24 = teeth in intermediate driven.
20 = „ „ driver.

Q. 10. What will be the cost of the following cloth with twist and weft at $8\frac{1}{2}$d per lb.?—32 inches, $117\frac{1}{2}$ yards, 72's reed, 15 picks per quarter, 60's twist, 72's weft; weaving, $2\frac{1}{8}$d per pick; other expenses according to your estimate. (35.) (O. 1895 C. G.)

Add 6 per cent. to cloth width to obtain width in reed. Add 6 per cent. to cloth length to obtain tapers length. Weight of warp equals—

32 + 6 per cent. = 33·9 in. width in reed.
72 reed used.
678
2373
2440·8 ends in warp.

$117\frac{1}{2}$ + 6 per cent. = 124 yards tapers length.
97632
840 48816
60 24408
50400) 302659·2 (6 lb., weight of warp.
302400
259·2

Weft—

33·9 width in reed.
60 picks per inch.

2034·0
117½ yards cloth length.

840 14238
72 2034

1680 2034
5880 1017

60480) 238995 (3·95 lb. weight of weft,
181440 or 3 lb. 15 oz.

575550
544320

312300
302400

9900

About 4 per cent. is generally added to weight of weft for waste. Therefore, weight of weft = 4 lb. 1½ oz.

Cost—	s.	d.
Warp, 6 lb., at 8½d per lb.	= 4	3
Weft, 4 lb. 1½ oz., at 8½d per lb.	= 2	11
Weaving, at 2⅛d per pick	= 2	7⅞
Expenses half weaving	1	4
	11	1⅞ cost of piece.

Q. 11. What counts of weft will be required to make the following cloth ?—38 inches wide, 38 yards long, 50's reed, 10 picks per quarter inch, 34's twist, with 120 per cent. added, piece to weigh 8¼ lb. (40.) (O. 1895 C. G.)

First find the weight of warp. Add 6 per cent. to

width of cloth to obtain the width in the reed. Add 6 per cent. to cloth length to obtain tapers length.

38 + 6 per cent. = 40·28 width in reed.
50 reed used.
2014·~~00~~ ends in warp.

38 + 6 per cent. = 40·28 tapers length.

```
  840      16112
   34       4028
 3360      80560
 2520
28560 ) 81123·92 ( 2·84 lb. weight of
        57120          warp.
        240039
        228480
         115592
         114240
           1352
```

2·84 with 120 per cent. added =

```
          2·84
           120
100 ) 340·80 ( 3·4 lbs. weight
       300          of size.
        408
        400
          8
```

Therefore weight of warp equals—

2·84 + 3·4 lb. weight of size = 6·24 lb.

The weight of the piece equals 8¼ lb., or 8·25. Therefore 8·25 less 6·24 = 2·01 lb. weight of weft.

To find the counts of the weft the rule is :—Width in reed multiplied by picks per inch multiplied by cloth length, and divided by 840 times weight.

40·28 width in reed.
40 picks per inch.
1611·20
38 yards cloth length.
128896
48336
61225·6 (36·2 counts of weft.
50652
105736
101304
44320
33768
10552

840
Weight = 2·01
840
16800
1688·40

Honours Grade.

Q. 10. A 5-end sateen is being made with 19 threads of 34's twist and 30 picks of 38's weft to the quarter inch. You are required to make a cloth equally firm with an 8-end sateen weave. Using the same counts of yarn, what number of ends and picks will you require? Using the same number of ends and picks, what counts of yarn will you require? What will be the weight in each case for 42 inches 90 yards? (30.) (H. 1895 C. G.)

First find the number of threads per inch required in the 8-end sateen.

Carry both patterns out to 40 ends, and find the ends plus intersections in each.

5-end sateen there are—

40 ends + 16 intersections = 56.

8-end sateen—

40 ends + 10 intersections = 50.

Therefore,

76 threads per inch.
56 ends + intersections in 5-end sateen.

456
380

Ends + intersections in 8-end sateen. } 50) 4256 (85·1 threads per in. required in the 8-end sateen.
400
256
250
61
50
11

Picks per inch required—

120 picks per inch.
56 ends + intersections in 5-end sateen.

720
600

Ends + intersections in 8-end sateen. } 50) 6720 (134·4 picks per in. required in the 8-end sateen.
50·
172
150
220
200
200
200

Counts of warp— 76 threads in given cloth.

$5{\cdot}83$ = square root of 34's.

228
608
380

Threads in required cloth. } 85) 443·08 ($5{\cdot}21^2$

425·
180
170
108
85
23

5·21
5·21
521
1042
2605
27·1441

27's counts of warp required in the 8-end sateen.

To find the counts of weft :—

120 picks in given cloth.

$6{\cdot}16$ = square root of 38's.

720
120
720

Picks in required cloth. } 134·4) 739·20 ($5{\cdot}5^2$

6720
6720
6720

5·5
5·5
275
275
30·25

Counts of weft required for 8-end sateen, $30\frac{1}{4}$'s.

Or $\frac{5{\cdot}83 \times 50}{56} = 5{\cdot}2^2 = 27$'s counts of warp.

$\frac{6{\cdot}16 \times 50}{56} = 5{\cdot}5^2 = 30\frac{1}{4}$'s counts of weft.

Weight of warp and weft in the first case, 5-end sateen—

42 in. 90 yds. 76×120. 34's twist, 38's weft.
Per inch.

Warp—Add 5 per cent. to cloth length to find tapers length.

42 inches width of cloth.
76 threads per inch.

252
294
3192

90 + 5 per cent. = $94\frac{1}{2}$ yards tapers length.

840 × 34 = 28560
2520 × 12768 = 32188320
28560) 32188320 (1127·04 lb. weight of warp.
28560
160440
142800
176400
171360
5040

Weft—

Add 6 per cent. to width of cloth to find the width in the reed.

42 + 6 per cent. = 44·5 inches width in the reed.

840 × 38 = 31920
2520 × 12768 = 32188320
31920) 32188320 (1008·15 lb. weight of weft.
31920
161400
159600
180000
159600
20400

Weight of warp and weft in the 8-end sateen—

1st case—

42 in. 90 yds. 85 × 134·4. 34's warp, 38's weft.
Per inch.

Warp—

42 inches width of cloth.
85 threads per inch.
210
336
3570
90 + 5 per cent. = 94½ yards tapers length.
14280
32130
1785
840 × 34 = 28560) 337365 (11·81 lb. weight.
28560
51765
28560
232050
228480
35700
28560
7140

Weft—

42 + 6 per cent. = 44·5 inches width in the reed.
134·4 picks per inch.
1780
1780
1335
445
5980·80
90
840 × 38 = 31920) 538272·0 (16·86 lb. weight.
31920
219072
191520
275520
255360
201600
191520
10080

2nd case.

42 in. 90 yds. 76 × 120. 27's warp, 30¼'s weft.

Warp—

Per inch.

42 inches width of cloth.
76 threads per inc .
252
294
3192

90 + 5 per cent. = 94½ yards. tapers length.

12768
28728
1596

840 × 27's = 22680) 301644 (13·3 lb. weight.
22680
74844
68040
68040
68040

Weft—

42 + 6 per cent. = 44·5 inches width in reed.
120 picks per inch.
53408
90 yards cloth length.

840 × 30¼'s = 25410) 480600 (18·91 lb. weight.
25410
226500
203280
232200
228690
35100
25410
9690

LANCASHIRE AND CHESHIRE EXAMINATION, 1896.

Q. 1. Assuming 60 yards of each of the following yarns to weigh 16 grains, and the fibres from which they are respectively spun to be:—Cotton, Flax, Spun Silk, and Worsted, how would you name them?

Cotton is based on the number of hanks of 840 yards each in 1 lb. weight. Therefore,

$$\frac{60 \times 7000}{840 \times 16} = 31{\cdot}25 \text{ counts.}$$

Or 60 yards weighs 16 grains.

$$840 \text{ yards weighs } \frac{16 \times 840}{60} = 224 \text{ grains.}$$

$$\frac{7000}{224} = 31{\cdot}25\text{'s counts.}$$

Linen or Flax is based on the number of leas of 300 yards each in 1 lb. weight.

Therefore,
$$\frac{60 \times 7000}{300 \times 16} = 87{\cdot}5\text{'s lea counts.}$$

Or 60 yards weighs 16 grains.

$$300 \text{ yards weighs } \frac{16 \times 300}{60} = 80 \text{ grains.}$$

$$\frac{7000}{80} = 87{\cdot}5\text{'s lea counts.}$$

Worsted is based on the number of hanks of 560 yds. each in 1 lb. weight.

Therefore,
$$\frac{60 \times 7000}{560 \times 16} = 46{\cdot}8 \text{ counts.}$$

Or 60 yards weighs 16 grains.

$$560 \text{ yards weighs } \frac{16 \times 560}{60} = 149{\cdot}\dot{3} \text{ grains.}$$

$$\frac{7000}{149{\cdot}\dot{3}} = 46{\cdot}8 \text{ counts.}$$

Spun Silk is the same as Cotton, 840 yards = 1 hank.
Therefore, $\frac{60 \times 7000}{840 \times 16} = 31{\cdot}25$'s counts.

Q. 2. A Grandrelle cotton thread of 20 hanks per lb. is required. It is to be composed of white, red, and blue. If the white is 60's, and the red 50's, what count of blue will be needed? Also what will be the cost per lb. of such a yarn, if the white is 13d, the red 15d, and the blue 17d per lb., the cost of doubling to be $1\frac{1}{2}$d per lb.?

1st. Find the resultant counts of 60's white and 50's red.

$$\frac{1000}{60} = 16{\cdot}66$$

$$\frac{1000}{50} = \frac{20{\cdot}}{36{\cdot}66} \qquad \frac{1000}{36{\cdot}66} = 27{\cdot}27\text{'s counts.}$$

2nd. Find the counts to double with 27·27's to equal 20's.

$$\frac{1000}{20} = 50{\cdot}$$

$$\frac{1000}{27{\cdot}27} = \frac{36{\cdot}66}{13{\cdot}34} \qquad \frac{1000}{13{\cdot}34} = 75\text{'s counts.}$$

To find the cost per lb.—

60's white at 13d per lb.
50's red „ 15d „
75's blue „ 17d „

60's and 50's = 27·27, therefore the price of 27·27's per lb. equals

60's at 15d =	900
50's at 13d =	650
110	1550

$\frac{1550}{110} = 14{\cdot}1$d per lb.

The price per lb. of 27·27 and 75's when twisted together equals

27·27 at 17d	= 463·59
75's at 14·1d	= 1057·5
102·27	1521·09

Therefore $\frac{1521{\cdot}09}{102{\cdot}27} = 14{\cdot}87$ with $1{\cdot}5$ added for doubling equals 16·37d price per lb. of the threefold yarn.

Q. 3. With the following positive motion for drawing away the cloth as it is woven, what change wheel would be used for 90 picks per inch :—The ratchet wheel has 50 teeth; the compounded stud wheels have 120 and 15 teeth respectively; the beam wheel has 75 teeth; and the beam circumference is 15 inches? What standard dividend would you employ to obtain wheels for any number of picks?

$$\frac{\text{Rack wheel. } 50 \times \text{Beam wheel. } 75 \times \text{Stud wheel. } 120}{\text{Pinion. } 15 \times \text{Circumference of beam in } \tfrac{1}{4} \text{ inches. } 60} = 500 + 1\tfrac{1}{2} \text{ per cent. for contraction equals } 507 \text{ the dividend.}$$

Therefore, $\frac{507}{22{\cdot}5} = 22$ wheel.

Picks per ¼ inch.

Q. 4. A warp, containing 2560 threads, all of which are 320 yards long, is to be made on a warping-mill whose circumference is 18 yards, and from a maximum of 200 bobbins, what weight of 50's twist will it contain? How many journeys will the "heck" make in order to provide the required number of threads? And how many times will the mill revolve in one direction to give the length?

The number of bobbins creeled will be 160; there will be 16 layers of yarn, which will equal $160 \times 16 = 2560$ ends in the warp, or the "heck" will make 16 journeys.

The number of revolutions made by the mill equals length divided by circumference of mill, therefore $320 \div 18 = 17{\cdot}77$ revolutions in one direction.

The weight of the warp equals—

$$\frac{2560 \times 320}{840 \times 50} = 19{\cdot}5 \text{ lb.}$$

Q. 5. How much 60's twist will be required to make a set of back beams which contain 2364 ends of 18000 yards, if $1\frac{1}{2}$ per cent. is allowed for waste?

$$\frac{2364 \times 18000}{840 \times 60} = 844{\cdot}28 \text{ lb.} + 1\tfrac{1}{2} \text{ per cent. for waste.}$$

$1\frac{1}{2}$ per cent. $= 12{\cdot}66$ lb. Therefore $844{\cdot}28 + 12{\cdot}66 = 856{\cdot}94$ lb.

Q. 6. What length of warp will 64 lb. of 2/70's twist give, if there are 2260 threads, and if in winding and warping $1\frac{1}{4}$ per cent. of the material is wasted?

The weight of yarn, after allowing $1\frac{1}{4}$ per cent. for waste, will equal 64 lb. less ·8 lb. $= 63{\cdot}2$ lb.

In 1 lb. of 2/70's there will be $35 \times 840 = 29400$ yards. Therefore,

$$\frac{840 \times 35 \times 63{\cdot}2}{2260} = 822{\cdot}1 \text{ yards.}$$

Q. 7. What percentage of size remains upon the warp threads when in a plain fabric, if the piece weighs 12 lbs., and is constructed as follows:—30 yards long, 44 inches wide, 14×14 ends and picks per quarter inch of 20's warp and 22's weft, full and true in every particular?

1st. Find the weight of warp and weft in the piece.

44 inches, 30 yards, 14×14, 20's warp, 22's weft.

In the making of the cloth, allowing 6 per cent. for contraction in width, and 6 per cent. for contraction in length, the weight of warp equals—

$$\frac{46{\cdot}6 \times 56 \times 31{\cdot}8}{840 \times 20} = 4{\cdot}93 \text{ lb.}$$

The weight of weft equals—

$$\frac{46{\cdot}6 \times 56 \times 30}{840 \times 22} = 4{\cdot}23 \text{ lb.}$$

The total weight of warp and weft equals $4{\cdot}93 + 4{\cdot}23 = 9{\cdot}16$ lb., the piece weighs 12 lb., the difference in weight between 12 lb. and 9·16 lb. is 2·84 lb., which is size.

To find the percentage, $2{\cdot}84 \times 100$ divided by the weight of yarn sized.

$$\frac{2{\cdot}84 \times 100}{4{\cdot}93} = 57{\cdot}6 \text{ per cent.}$$

Q. 8. What is the value of the material in a striped fabric consisting of satin and plain weaves, the former having 72 ends of 50's at 9d per lb., and the latter 48 ends of 24's at $6\frac{1}{4}$d per lb. in each of 40 repeats of this pattern, the piece to be 110 yards long, 50 inches wide, and to contain 70 picks per inch of 50's weft at $7\frac{1}{2}$d per lb. ? The contraction warp-way is, for the satin 5 per cent., for the plain 10 per cent., and weft-way 6 per cent.

Satin stripe, 72 ends of 40 repeats = 2880 ends ; 110 yards + 5 per cent. for contraction, 50's yarn.

$$\frac{2880 \times 115{\cdot}5}{840 \times 50} = 7{\cdot}92 \text{ lb.}$$

Plain stripe, 48 ends of 40 repeats = 1920 ends ; 110 yards + 10 per cent. for contraction. 24's yarn.

$$\frac{1920 \times 121}{840 \times 24} = 11{\cdot}52 \text{ lb.}$$

Weight of weft.

$$\frac{53 \times 70 \times 110}{840 \times 50} = 9{\cdot}71 \text{ lb.}$$

Cost—

			Pence.	
Warp, 7·92 lb.	50's at 9d	per lb.	= 71·28	
Warp, 11·52 „	24's at 6¼d	„	= 72·	
Weft, 9·71 „	50 at 7½d	„	= 72·82	s. d.
			216·10	= 18 0.

Q. 9. How many hanks—for each colour—must be sent to the dyehouse in order to produce 50 warps, all striped to the accompanying pattern, each warp to have 1280 ends and to be 110 yards long, after an allowance of 2½ per cent. has been made for waste in working?

Pattern.—5 red, 4 indigo, 2 sky, 4 fawn, 10 red, 4 fawn, 2 sky, 4 indigo, 5 red. Total 40.

The different coloured ends in the warp are—

20 Red
8 Indigo
4 Sky
8 Fawn
40 ends.

The number of hanks in one warp equals—

$$\frac{1280 \times 110}{840} = 167{\cdot}62$$

This is the number of hanks after 2½ per cent. has been deducted, the actual number of hanks required in each warp equals—

$$\frac{167{\cdot}62 \times 100}{97{\cdot}5} = 171{\cdot}92 \text{ hanks.}$$

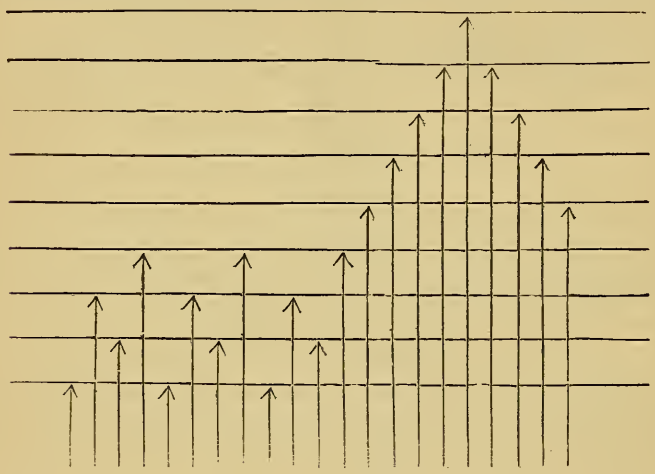
The number of ends in the pattern equals 40, therefore the number of hanks of the respective colours will equal—

	Hanks.
Red, 171·92 ÷ 40 ends = 4·298 hanks per end × 20 ends - - - - - - -	= 85·960
Sky, there is ⅕ the weight of red - - -	= 17·192
Indigo, there is twice the weight of sky -	= 34·384
Fawn, there is same weight as indigo - -	= 34·384
Total hanks for one warp =	171·920

For 50 warps—

Red,	85·96	hanks × 50	-	-	= 4298	hanks.
Sky,	17·192	,,	,,	-	859·6	,,
Indigo,	34·384	,,	,,	-	1719·2	,,
Fawn,	34·384	,,	,,	-	1719·2	,,
		Total hanks for 50 warps =			8596 0	

Q. 10 Assuming the accompanying draft to be used in making a cloth, the threads of which cover a space of 34 inches in a reed having 36 dents per inch, and are passed in pairs through every dent, give the healds per stave, and define the positions of the eyes upon each stave.



36 dents per inch gives a 72 reed.

34 in. width × 72 reed used gives 2448 ends.

There are 21 ends in the pattern, therefore 2448 ÷ 21 = 116 patterns and 12 ends over; assuming that the other selvege of the cloth is plain, the 12 ends over will serve for the purpose. Therefore on shafts—

		Pattern, ends per pattern.		Ends on each. Staves.	
1 to 4,	there will be	(116 × 3) + 3 over	= 351 × 4 =		1404
5 to 8,	,,	(116 × 2)	= 232 × 4 =		928
9	,,	(116 × 1)	= 116 × 1 =		116
			Total ends,		2448

The position of the eyes on the staves will be determined thus—

There are 21 ends in one repeat; using a 72 reed gives a rate of 18 per inch for the 4 front staves. As 4 does not go into 21 without a remainder, the pattern is carried out to 4 repeats, or 84 ends. A knit or a miss will equal 4 threads. K = knit, M = miss.

Staves.	Rate.	29 REPEATS.				Selvage.	Stitches knit ot these staves.
		1st Repeat.	2nd Repeat.	3rd Repeat.	4th Repeat.		
1 to 4	72	K3 M2	K3 M2	K3 M2	K3 M3	K3	1404
5 to 8	„	M2 K1 M1 K1	M2 K1 M1 K1	M2 K1 M1 K1	M3 K1 M1 K1		928
9	„	M4 K1	M4 K1	M4 K1	M5 K1		116
							2448

Q. 11. A shuttle is $1\frac{1}{8}$ inches deep by $1\frac{1}{4}$ inches wide. It enters the warp when the reed is $4\frac{1}{2}$ inches from the fell of the cloth; the front heald stave being 9 inches from the fell. What must be the lift of that stave?

When the reed is $4\frac{1}{2}$ inches from the fell of the cloth the shuttle is entering the shed, therefore at $4\frac{1}{2}$ inches less $1\frac{1}{4}$ inches the width of the shuttle, namely $3\frac{1}{4}$ inches from the fell of the cloth, the depth of the shed will equal the depth of the shuttle $1\frac{1}{8}$ inches, the depth of the shed at 9 inches from the fell of the cloth will be greater.

$$\frac{1\frac{1}{8} \times 9}{3\frac{1}{4}} = 3{\cdot}11 \text{ inches the lift of the front heald.}$$

Q. 12. A tappet is driven by a train of 4 wheels, the last of the series having 160 teeth. How many teeth should each of the remaining wheels contain, if the crank shaft make 16 revolutions for the tappet 1?

Assuming a crank shaft pinion of 20 teeth; the number of teeth in the two intermediates will be—

Driven intermediate $20 \times 16 = 320$ } or any ratio of these
Driver ,, $160 = 160$ } numbers,
say 32 and 16, or 64 and 32.

City and Guilds of London Examination, 1896.

Q. 1. From 800 lbs. of 70's T. you are required to prepare a set of six warpers' beams, each containing 15,854 yards, $1\frac{1}{4}$ per cent. being allowed for waste in winding and beaming. What number of ends will you put on each beam? (20.) (O. 1896, C. G.)

800 lb. less $1\frac{1}{4}$ per cent. (10 lb.) = 790 lb.

Therefore, $$\frac{790 \times 840 \times 70}{15854} = 2930 \text{ ends.}$$

Made up from 5 beams of 488 ends each = 2440 ends + 1 beam of 490 ends = 2930 ends.

Q. 2. A piece of cloth one yard square, weighing one-fifth of a pound contains 78 threads of 40's twist and 70 threads of 50's weft per square inch. What percentage of size would you put on the twist in order to obtain the above weight when woven? (25.) (O. 1896 C. G.)

Allowing 6 per cent. for contraction in width and 6 per cent. for milling up in length, the weight of warp equals—

$$\frac{36 \times 78 \times 1 \times 16 + 6\%}{840 \times 40} = 1{\cdot}41 \text{ oz.}$$

(Oz. For length.)

Weight of weft equals—

$$\frac{36 \times 78 \times 1 \times 16 + 6\%}{840 \times 50} = 1{\cdot}017 \text{ oz.}$$

(Oz. For width.)

The total weight = 1·41 + 1·017 = 2·427 oz.

The sample weighs 3·2 oz.; the difference, which is size, is 3·2 – 2·427 = ·773.

The percentage of size equals—

$$\frac{{\cdot}773 \times 100}{1{\cdot}41} = 54{\cdot}8 \text{ per cent. of size.}$$

Q. 3. Given a warp of 900 yards of 32's twist, 2,400 ends, to be drawn into a 70 reed (Stockport counts), and woven into a plain cloth with 21 picks of 36's weft per quarter inch, how many yards of cloth should this make, and of what width? If the weave were changed to a two and one twill, what difference (if any) would there be in the width and length of the cloth? (30.) (O. 1896, C. G.)

Particulars of Cloth, Plain :—900 yards, 2400 ends, 70 reed, 21 picks per $\frac{1}{4}$ inch, 32's twist, 36's weft. Allow 6 per cent in length for milling up; allow 6 per cent. in width for contraction. Therefore

$\frac{2400}{70} = 34{\cdot}28$ in. width in reed, less 6 per cent. (2 in.) = 32·28 in. width of cloth.

900 yards length of warp, less 6 per cent. (51 yards) = 849 yards length of cloth.

Particulars of Cloth, Twill :—900 yards, 2400 ends, 70 reed, 21 picks per $\frac{1}{4}$ inch, 32's twist, 36's weft. Allow 4 per cent. in length for milling up; allow 4 per cent. in width for contraction. Therefore,

$\frac{2400}{70} = 34{\cdot}28$ in. width in reed, less 4 per cent. (1·31) = 32·97 in. width of cloth.

900 yards length of warp, less 4 per cent. (34·6) = 865·4 yards length of cloth.

Q. 4. Explain the difference between Pickles' taking-up motion and a positive taking-up motion of an older style. For the latter kind what circumference of emery beam will be required to put in 21·75 picks per quarter inch, the train of wheels being as follows :—Beam wheel 75, rack wheel 48, stud wheel 120, little pinion 15, change wheel 24? (25.) (O. 1896, C. G.)

For particulars in respect to these two motions see page 60. Referring to the question—

$$\frac{48 \times 120 \times 75}{15 \times 24 \times 21{\cdot}75} = 55{\cdot}17 \text{ quarter inches cir. of beam.}$$

55·17 quarter inches circumference of beam will give 21·75 picks per quarter inch in the loom, but $1\frac{1}{2}$ per cent. more picks out of the loom. If 21·75 picks per quarter out of the loom is required, then the circumference of the beam will be 55·17 + $1\frac{1}{2}$ per cent. (·827) = 55·99 quarter inches; practically 14 inches.

Q. 5. How would you estimate what to allow for contraction in width and length during weaving for each of the following cloths?

Cloth.	Width.	Length.	Count of Reed.	Picks per ¼ inch.	Twist.	Weft.	Weave.
1.	44 ins.	27½ yds.	96	28	50s	50s	plain
2.	33 „	80 „	68	16	28s	26s	2 and 2 twill
3.	46 „	24 „	60	10	40s	40s	pure gauze
4.	32 „	89 „	70	38	32s	38s	5-end satin

(30.) (O. 1896, C. G.)

To estimate the amount of contraction in width and length for a piece is most difficult, unless previous experience can be called upon. On page 21 it is stated that 6 per cent. must be allowed for length and 6 per cent. for width when weaving plain cloth 16 × 16, 32's twist and 50's weft.

In the present example, plain cloth 24 × 28 50's twist and 50's weft, taking a mean of 26 × 26, the contraction for length will be about $\frac{26 \times 6}{16} = 9{\cdot}75$ per cent., and about the mean between 6 per cent. and 9 per cent. for width, say about 7½ per cent., but this is not altogether a safe way.

The contraction for the twill working from a 6 per cent. basis would be less than 6 per cent., but owing to the coarse yarns—28's and 26's—6 per cent. will be required in width and length.

The pure gauze, with 10 picks per quarter and 40's and 40's, will take up not more than 6 per cent. in width and 9 per cent. in length.

The sateen will require the least allowance, and 4 per cent. in width and 4 per cent. in length will be sufficient to allow.

Q. 6. A threefold end which wraps 8's is known to contain one end each of 14's and 56's. What is the count of the third end? (10.) (O. 1896 C. G.)

$\frac{1000}{14} = 71{\cdot}42$ grs.

$\frac{1000}{56} = \frac{17{\cdot}85 \text{ ,,}}{89{\cdot}27 \text{ grs.}}$

$\frac{1000}{89{\cdot}27} = 11{\cdot}2$'s resultant counts of 14's and 56's.

To find the counts to double with 11·2 that the result will equal 8's.

$\frac{1000}{8} = 125$ grs.

$\frac{1000}{11{\cdot}2} = \frac{89{\cdot}27 \text{ ,,}}{35{\cdot}73 \text{ grs.}}$ the difference in the two weights.

$\frac{1000}{35{\cdot}73} = 28$'s the counts required to double with 14's and 56 that the results may equal 8's.

Q. 7. Assuming a square yard of cloth G to weigh 4 ounces, what percentage of size would you put on 30's twist in order to obtain that weight when woven with 30's weft? What will be the cost of a piece 38 inches wide, $38\frac{1}{2}$ yards long (on the counter), with yarns at an average price of $6\frac{5}{8}$d, in the cop; weaving $8\frac{1}{2}$d; other expenses (not including cost of size) 9d? (20.) (H. 1896, C. G.)

1st part of question, assuming that cloth G contains 52 ends and 60 picks per inch.

The weight of warp equals—

$$\frac{38 \text{ in.} \times 52 \times 16 \text{ oz.}}{840 \times 30} = 1{\cdot}254 \text{ oz.}$$

Weight of weft equals—

$$\frac{38 \text{ in.} \times 60 \times 16 \text{ oz.}}{840 \times 30} = 1{\cdot}447 \text{ oz.}$$

Total weight equals $1{\cdot}254 + 1{\cdot}447 = 2{\cdot}701$ oz.

Sample weighs 4 oz., therefore 4 oz. less 2·701 oz. = 1·299 oz. size.

$$\frac{1{\cdot}299 \times 100}{1{\cdot}254} = 103{\cdot}6 \text{ per cent.}$$

2nd part of question, allowing about $5\frac{1}{2}$ per cent. for width and $5\frac{1}{2}$ per cent. for length, so that the width in the reed will be 40 inches; tapers length 40 yards, weight of warp equals—

$$\frac{38 \times 52 \times 40}{840 \times 30} = 3{\cdot}14 \text{ lb.}$$

Weight of weft equals—

$$\frac{40 \times 60 \times 38\frac{1}{2}}{840 \times 30} = 3{\cdot}66 \text{ lb.} + 4 \text{ per cent. for waste } (\cdot 14) = 3{\cdot}8 \text{ lb.}$$

Cost—

	Pence.
Warp, 3·14 lb., at $6\frac{5}{8}$ per lb., -	20·8
Weft, 3·8 lb., „ -	25·1
Weaving, - - - -	8·5
Expenses, - - - -	9·0
	$63{\cdot}4 = 5/3\frac{1}{2}$

Q. 8. Taking the diameter of a thread of 70's as $\frac{1}{230}$th of an inch, what will be the count of a thread whose diameter is $\frac{1}{305}$th of an inch. If with the 70's warp and weft a plain cloth is being woven 26 × 30 to the quarter inch, what number of ends of the other thread must be used for a 2 and 2 twill to give a cloth of equal firmness? (25.) (H. 1896 C. G.)

1st part of the question—

Square root of $70 = 8{\cdot}36$

Therefore $\frac{8{\cdot}36 \times 308}{230} = 11{\cdot}2$; $11{\cdot}2^2 = 125$ counts.

2nd part of the question—

With 70's warp and weft a cloth is woven, with 26 ends and 30 picks per quarter inch, or 104 ends 120 picks per inch ; if 125 counts are used, the number of ends and picks in plain cloth will equal—

$\frac{104 \times 11{\cdot}2}{8{\cdot}36} = 139$ threads. $\frac{120 \times 11{\cdot}2}{8{\cdot}36} = 161$ picks.

This plain cloth, using 125 counts, is changed to a 2 and 2 twill, the number of ends and picks per inch will equal—

Ends $4 + 4$ intersections $= 8$ in plain cloth.

Ends $4 + 2$,, $= 6$ in 2 and 2 twill.

Therefore, $\frac{139 \times 8}{6} = 185$ threads. $\frac{161 \times 8}{6} = 214$ picks.

LANCASHIRE AND CHESHIRE EXAMINATION, 1897.

Q. 1. If from a cop four separate leas be wrapped, and the total wrappings are found to weigh 2 dwts. 20 grains, what count is the yarn?

$$\frac{4000}{68} = 58{\cdot}8\text{'s counts.}$$

Q. 2. What does a 40 Bolton reed equal by the Radcliffe, Stockport, and Scotch systems of naming reeds?

The different systems are :—

Stockport, based on the number of dents on 2 inches.

Radcliffe, based on the number of dents on 1 inch.

Bolton, based on the number of beers on $24\frac{1}{4}$ inches (a beer equals 20 dents).

Scotch, based on the number of 100 dents on 37 inches.

Scotch, based on the number of porters on 37 inches (a porter equals 20 dents).

In converting the counts of reeds from one system to another, find the dents per inch in each system; then multiply the given counts by the dents per inch of its own system, and divide by the dents per inch of the system required, thus :—

System.	Dents.		Inches. Space Occupied.		Dents per Inch.
Stockport,	1	÷	2	=	·5
Radcliffe,	1	÷	1	=	1
Bolton,	20	÷	$24\frac{1}{4}$	=	·8247
Scotch,	100	÷	37	=	2·7027
Scotch,	20	÷	37	=	·5405

Taking now the question—

Converted to Radcliffe, $\frac{\cdot 8247 \times 40}{1} = 32 \cdot 988$ counts.

Converted to Stockport, $\frac{\cdot 8247 \times 40}{\cdot 5} = 66$ counts (nearly).

Converted to Scotch, $\frac{\cdot 8247 \times 40}{2 \cdot 7} = 12 \cdot 2$ counts.

Converted to Scotch, $\frac{\cdot 8247 \times 40}{\cdot 5405} = 61$'s counts.

Q. 3. There are 190 bobbins each containing 12 oz. of 16's twist, from which it is desired to make a warp of 2400 ends. What length can be obtained if the wasted material and that left on the bobbins equal 6 per cent. of the whole?

The weight of yarn equals 190×12 oz. $= 2280$ oz. less 6 per cent. (which equals 136 oz) equals 2144 oz., or 134 lb.

Therefore—

$$\frac{134 \times 840 \times 16}{2400} = 750 \cdot 4 \text{ yards, or } 750 \text{ yards } 15 \text{ inches.}$$

Q. 4. What is the average count of material in 1 square yard of a fabric composed of 56 ends per inch of 18's twist and 160 picks per inch of 38's weft?

The weight of warp and weft in the sample, without allowing anything for contraction, equals—

Weight of warp, $\frac{56 \times 36 \times 7000}{840 \times 18} = 933{\cdot}3$ grains.

Weight of weft, $\frac{160 \times 36 \times 7000}{840 \times 38} = 1263{\cdot}$ grains.

$2196{\cdot}3$ total weight in grains.

The total length in yards of warp and weft equals—

Warp, $56 \times 36 = 2016$ yards; weft, $160 \times 36 = 5760$; therefore $2016 + 5760 = 7776$ yards. The average counts equals—

$$\frac{7776 \times 7000}{2196{\cdot}3 \times 840} = 29{\cdot}5 \text{ counts.}$$

Proof—

$$\text{Warp, } \frac{56 \times 36 \times 7000}{840 \times 29{\cdot}5} = 569 \text{ grains.}$$

$$\text{Weft, } \frac{160 \times 36 \times 7000}{840 \times 29{\cdot}5} = 1627 \text{ grains.}$$

Total weight equals, $569 + 1627 = 2196$ grains.

Q. 5. What are the respective diameters of 10's, 20's, 30's, and 40's cotton yarns?

$840 \times 10 = 8400$; square root of $8400 = 91{\cdot}6$, less 10 per cent. $(9{\cdot}1) = \frac{1}{82{\cdot}5}$ dia. of 10's

$840 \times 20 = 16800$; square root of $16800 = 129{\cdot}6$, less 10 per cent. $(12{\cdot}9) = \frac{1}{116{\cdot}7}$ dia. of 20's.

$840 \times 30 = 25200$; square root of $25200 = 158{\cdot}7$, less 10 per cent. $(15{\cdot}8) = \frac{1}{142{\cdot}9}$ dia. of 30's.

$840 \times 40 = 33600$ square root of $33600 = 183{\cdot}3$, less 10 per cent. $(18{\cdot}3) = \frac{1}{165}$ dia. of 40's.

Q. 6. A warp contains 3200 ends. It is 730 yards long. It is sized to the extent of 24 per cent., and weighs 150 lbs. What is the count of the pure yarn?

The weight of the pure yarn before sizing equals—

$$\frac{150 \times 100}{124} = 121 \text{ lb. (nearly).}$$

Therefore,

$$\frac{3200 \times 730}{840 \times 121} = 23\text{'s counts (nearly).}$$

Q. 7. A set of healds knitted for a 78 reed has to be used with a 64 reed. How many eyes must be left empty, and in what order?

The difference between a 78 reed and a 64 reed gives 14 heald eyes per inch, or 28 on 2 inches. So as to miss an equal gait through on four staves, miss after the first inch 12 heald eyes, miss after the second inch 16 heald eyes, and so on repeating.

Q. 8. Give the rate and order of knitting the healds for a striped fabric consisting of three shaft twill, three ends in a dent, and six shaft sateen, four ends in a dent. The reed to be a 70 (Stockport count), the pattern to repeat on two inches of width, the twill stripe to be $\frac{3}{5}$ and the satin stripe $\frac{2}{5}$ of a repeat. The piece to be 36 inches wide, and a twill stripe to join each selvage?

The width of each stripe will be—

$$\text{Twill stripe, } \frac{2 \times 3}{5} = 1{\cdot}2 \text{ inches.}$$

$$\text{Sateen stripe, } \frac{2 \times 2}{5} = \cdot 8 \text{ inches.}$$

The number of ends in the respective stripes will be—

$$\text{Twill, 70 reed, 3 in a dent} = \frac{70 \times 3}{2} \overset{\text{Per Inch.}}{=} 105 \times 1{\cdot}2'' = 126 \text{ ends.}$$

$$\text{Sateen, 70 " 4 " } = \frac{70 \times 4}{2} = 140 \times \cdot 8'' = 112 \text{ "}$$

To find the rate per inch to knit the healds, find which is the finer set, twill or sateen.

$$\text{Twill, 105 per inch on 3 staves} = \frac{105 \times 4}{3} = 140\text{'s set.}$$

$$\text{Sateen, 140 per inch on 6 staves} = \frac{140 \times 4}{6} = 93\text{'s set.}$$

The Twill is knit at the rate of 140. The K and M in one repeat of the pattern equals K42 M28 = 70 dents. In the Sateen the $18\frac{1}{2}$ knit must occupy the same space as the 28 miss in the Twill, to find the rate to knit the Sateen, $140 \times 8\frac{1}{2} \div 28 = 93$ as the rate. The knitting is shown below.

Staves.	Rate.	Selvage.	Stitches Knit and Missed.	Selvage.	Threads Represented.
1, 2, & 3	140	K21	M28 K42 finish with M28	K21	$(42 \times 17 \times 3) + (42 \times 3) = 2268$ Twill.
4, 5, 6, & 7	93		K19 M28 „ K19		$(19 \times 17 \times 4) + (19 \times 4) = 1368$ Sateen.
8 & 9	„		K18 M29 „ K18		$(18 \times 17 \times 2) + (19 \times 2) = 648$ „
			17 repeats.		Ends in warp, 4284

In the warp there are 18 repeats, and as the stripes contain respectively—Twill, 126 ends; Sateen, 112 ends—or 238 in both, the number of ends in the warp equals $238 \times 18 = 4284$. The pattern ends up with half a Twill stripe at each selvage.

Q. 9. If the tin roller of a slashing machine is 14·4 inches in circumference, the bell wheel has 45 teeth, and the worm is single, how many teeth must the tin roller wheel and the stud wheels contain in order to mark the warp every $42\frac{1}{4}$ yards. Make a sketch of the train.

The length of mark in inches equals 42 yards 9 in. × 36 = 1521 inches.

Therefore— 1521 gives the stud wheel.
648 „ tin roller wheel.

Or any ratio of these two numbers.

$$\frac{1521}{648} = \frac{2{\cdot}347}{1} = \frac{2{\cdot}347 \times 49}{1 \times 49} = \begin{matrix} 115 \text{ stud wheel.} \\ 49 \text{ tin roller wheel.} \end{matrix}$$

Q. 10. A five to the round tappet is to be driven from the bottom shaft. It is placed inside the loom framing and under the healds. Assuming the crank shaft pinion to contain 40 teeth, state the number of teeth in the other wheels employed, and make a sketch of the driving gear.

The sketch required for this question will be found on page 71.

A crank shaft pinion of 40 teeth is given, and the wheel on the bottom shaft, which gears with it, will contain 80 teeth on account of driving the bottom shaft of the loom, and to enable the picking and weft fork arrangement to work all right; the tappets are placed on a countershaft and are driven by a pair of wheels from the bottom shaft; the bottom shaft wheel is a driver and the counter shaft wheel a driven. To find the number of teeth in these two wheels.

5 × 40 = 200 driven wheel on tappet shaft.
80 driving „ bottom shaft.

Or any ratio of these two numbers, say 60 and 24.

Q. 11. The main shaft of a weaving shed makes 120 revolutions per minute; it carries a bevel wheel of 50 teeth, which engages with a second bevel wheel having 49 teeth, and being fixed upon the line shaft. A drum upon the line shaft, 15 inches in diameter, drives a pulley 9 inches in diameter, which is fitted upon the loom shaft. What length of cloth, having 110 picks per inch, will such a loom produce in $56\frac{1}{2}$ hours, if $\frac{1}{7}$ of the time is allowed for stoppages?

The speed of the loom equals—

$$\frac{120 \times 50 \times 15}{49 \times 9} = 204 \text{ picks per minute.}$$

The amount of cloth produced per week equals—

$$\frac{204 \times 60 \times \overset{\text{Working time.}}{48{\cdot}43}}{110 \times 36} = 149{\cdot}6 \text{ yards, or 149 yards } 21\tfrac{1}{2} \text{ in.}$$

Q. 12. Assuming two looms to run at the same speed, and that the cranks of one loom describe circles $5\frac{1}{2}$ inches in diameter, that those of the other describe circles 7 inches in diameter; what relation will the beating up force of the last named bear to the first?

Let A equal the loom with $5\frac{1}{2}$ inch cranks.

Let B „ „ 7 „

Then $5\frac{1}{2}^2 = A = 30{\cdot}25$

$7^2 = B = 49$

The relation in the force of beat up that B bears to A is as 49 is to 30·25, or as 1·619 is to 1.

City and Guilds of London Examination, 1897.

Q. 1. Explain the method of counting or numbering cotton yarns. In what manner would you test the counts of yarn supplied in cop, hank, or warp? What should be the weight of one lea of each of the following counts viz.:—12's, 25's, 32's, 40's; and if you had a

pound of each kind of yarn, what would be the total length of yarn in your possession? (15.) (O. 1897, C. G.)

For the first part of the question, see page 9.

$\frac{1000}{12} = 83{\cdot}33$ grains; 12×840 yards $= 10080$ yards.

$\frac{1000}{25} = 40$ grains; 25×840 yards $= 21000$ yards.

$\frac{1000}{32} = 31{\cdot}25$ grains; 32×840 yards $= 26880$ yards.

$\frac{1000}{40} = 25$ grains; 40×840 yards $= 33600$ yards.

Total length $= 91560$ yards.

Q. 2. What counts of folded yarn would result if 18's, 24's, and 36's cotton are twisted together; and what weight of each would there be in 240 lbs. of the folded yarn? Also, what would be the average counts of a warp composed as follows:—

4	threads	of 24's	twist.
2	„	18's	„
4	„	36's	„
2	„	18's	„
12	?		

(15.) (O. 1897, C. G.)

1st part of question—

$\frac{1000}{18} = 55{\cdot}55$ grains.

$\frac{1000}{24} = 41{\cdot}66$ grains.

$\frac{1000}{36} = 27{\cdot}77$ grains.

$124{\cdot}98$ grains.

The total weight of the three leas is practically 125 grs. Therefore, $\frac{1000}{125} = 8$'s counts.

In 240 lb. of 8's there are $8 \times 240 = 1920$ hanks.

In every lea of 8's there are 55·55 grains of 18's. Therefore weight of 18's equals—

$$\frac{55{\cdot}55 \text{ grs.} \times 7 \text{ leas per hank} \times 1920 \text{ hanks}}{7000} = 106{\cdot}65 \text{ lb.}$$

In every lea of 8's there are 41·66 grains of 24's. Therefore weight of 24's equals—

$$\frac{41{\cdot}66 \times 7 \times 1920}{7000} = 79{\cdot}987 \text{ lb.}$$

In every lea of 8's there is 27·77 grains of 36's. Therefore weight of 36's equals—

$$\frac{27{\cdot}77 \times 7 \times 1920}{7000} = 53{\cdot}328 \text{ lb.}$$

Total weight = 106·65 + 79·987 + 53·328 = 239·95 lb., practically 240 lb.

2nd part of question

4 threads of 24 ;	4 leas of	24's	weigh	166·66 grs.
18's; 2	„	18's	„	111·11 „
36's; 4	„	36's	„	111·11 „
18 ; 2	„	18's	„	111·11 „
12 leas.				499·99

The total weight is say 500 grs. This weight divided into as many thousands as leas taken (12,000) gives counts.

$$\frac{12{,}000}{500} = 24\text{'s average counts.}$$

Q. 3. What counts of healds would you choose to use

for each shaft of the following draft, and how would you drop them in order to avoid unnecessary friction if required to be woven 72 ends per inch in the reed? Also supposing it was considered advisable to order healds knit specially to pattern, in what form would you give out instructions for same—the warp to contain 2,322 ends (including selvage), and to stand $32\frac{1}{4}$ inches in width?

| | | |

Staves.	Sett.	Stitches Taken and Dropped in one Repeat of the Pattern.	Total T and D.	Value of T and D.	Threads Repre-sented.
1	144	T3 D6 T3 D6	18	2	36
2	,,	T3 D5 T4 D2 T1 D2 T1	,,	,,	,,
3 and 4	,,	D3 T1 D4 T1 D3 T1 D1 T2 D1 T1	,,	,,	,,
5	,,	D3 T1 D6 T1 D3 T1 D2 T1	,,	,,	,,
6 and 7	72	D2 T2 D5	9	4	,,
8	,,	D3 T1 D5	,,	,,	,,

In ordering the healds to be knit to the pattern, still using a 72 reed, the number of repeats will equal $\frac{2322}{36} = 64$, with 18 ends over. Allowing the 18 ends

for selvage, 6 of the ends to be taken in along with the 6 single ones on the left, and 12 at the other selvage will make the selvages equal. The order of knitting is as follows. Let K = knit, M = miss :—

Staves.	Rate	Stitches Knit and Missed.	Selvage.	Stitches Knit on these Staves.
1	144	K3 M6 K3 M6	K3	384
2	"	K3 M5 K4 M2 K1 M2 K1	K3	576
3 and 4	"	M3 K1 M4 K1 M3 K1 M1 K2 M1 K1		768
5	"	M3 K1 M6 K1 M3 K1 M2 K1		256
6 and 7	72	M2 K2 M5		256
8	"	M3 K1 M5		64
		64 repeats.		2304
			Selvage,	18
			Ends in the warp.	2322

Q. 4. Calculate the cost per yard (loom state) for the following cloth to particulars given, viz. :—100 yards cloth from 108 yards of warp, 42 inches wide, and 66 ends per inch in reed of 32 twist at 8½d per lb. in the cop, and woven with 16 picks to ¼ inch of 28 cops at 6½d per lb.

For winding cops on to warper's bobbins, allow 1d per lb.

„ warping, allow 3d per 1000 hanks.

„ slasher sizing, allow ¼ per lb.

„ twisting, allow 3d per 1000 ends (based upon a 500 yard warp).

„ weaving, allow 2d per pick per ¼ inch for 100 yards cloth.

„ extra charges to cover engine-power, rents, taxes, and standing expenses; allow three-fourths of weaving cost; allow 5 per cent. waste both in warp and weft. Fractional parts of ounces or pence need not be reckoned. (O. 1897 C. G.)

Particulars of cloth, using a 45 inch reed space loom—

42 inches wide, 100 yards, 66 reed, 16 picks per ¼ inch, 32's twist at 8½d; 28's weft at 6½d; allowing 6 per cent. for width.

Weight of warp—

42 inches + 6 per cent. (2·5) = 44·5 inches width in reed

$$\frac{44{\cdot}5 \times 66 \times 108}{840 \times 32} = 11{\cdot}8 \text{ lb.} + 5 \text{ per cent. } (\cdot 59)\ 12{\cdot}39 \text{ lb.}$$

Weight of weft—

$$\frac{44{\cdot}5 \times 64 \times 100}{840 \times 28} = 12{\cdot}11 \text{ lb.} + 5 \text{ per cent. } (\cdot 6) = 12{\cdot}71 \text{ lb.}$$

Cost—	Pence.
Warp, 12·39 lb., at 8½d per lb.,	105·31
Winding, 1d per lb.,	12·39
Warping, 3d per 1000 hanks,	1·20
Sizing, ¼d per lb.,	3·09
Twisting, 3d per 1000 ends (for 500 yds. warp),	1·80
Weft, 12·71 lb., at 6½d per lb.,	82·61
Weaving, 2d per pick for 100 yards,	32·00
Standing charges, three-fourths of weaving,	24·00
Price per 100 yards,	262·40

$$\frac{262\cdot40}{100} = 2\cdot62\text{d price per yard.}$$

Q. 5. If you had to produce a blue-white and red grandrelle thread equal to 10's, the blue to be 30's counts and the white 20's, what must be the counts of the red? Also, what would be the cost per lb. of the grandrelle if the 30's blue cost 12d per lb., the 20's white 8d per lb., and the red 18d per lb.—cost of doubling 1¾d per lb.? (15.)

$$\frac{1000}{20} = 50 \quad \text{grains.}$$

$$\frac{1000}{30} = 33\cdot33 \quad \text{,,}$$

$$83\cdot33$$

$$\frac{1000}{83\cdot33} = 12\text{'s, the resultant counts of 20's and 30's.}$$

$$\frac{1000}{10} = 100$$

$$\frac{1000}{12} = 83\cdot33$$

$$16\cdot67 \text{ difference between the two weights.}$$

$$\frac{1000}{16\cdot67} = 60\text{'s, the counts of the red thread.}$$

Cost—

30's at	8d	= 240
20's at	12d	= 240
50		480

$\frac{480}{50}$ = 9·6d per lb. for 12's

12's at	18d	= 216
60's at	9·6d	= 576
70		792

$\frac{792}{70}$ = 11·3d per lb., the cost of the three-fold, with $1\frac{3}{4}$d per lb. added for doubling equals 12·05 pence.

CITY AND GUILDS OF LONDON EXAMINATION, 1898.

What do you understand by the "Counts of cotton yarn?" (*a*) What would be the counts if two hanks of yarn weighed 9 dwts. $2\frac{3}{4}$ grs. (*b*) Also if $10\frac{1}{2}$ yards of a warp containing 2,400 ends weighed $7\frac{1}{2}$ ounces? (*c*) Also give the length of yarn you would expect to find on 4 cops of 24's if they weighed $3\frac{1}{2}$ ounces? *1st year.*

The term counts of yarn, means the number of hanks (840 yards) to the lb.

(*a*) $\frac{2 \times 840 \times 7000}{840 \times 218{\cdot}75 \text{ grs.}} = 64$'s counts.

(*b*) $\frac{10{\cdot}5 \times 2400 \times 16}{840 \times 7{\cdot}5} = 64$'s counts.

(*c*) $\frac{840 \times 24 \times 3{\cdot}5}{16} = 4410$ yards.

What would be paid for the winding, warping, and drawing-in of a warp containing 2,400 ends, 720 yards, 24's counts, if the rate of pay was 6d. per bundle (10lbs.) for winding, 7d. per 1,000 hanks for warping, and $5\frac{3}{4}$d. per 1,000 ends for drawing-in.—*1st year.*

Winding— $\frac{2400 \times 720}{840 \times 24} = 85{\cdot}7$ lbs.

$\frac{85{\cdot}7 \times 6}{10} = 51{\cdot}4$d.

Warping—

$85{\cdot}7 \times 24 = 2057$ hanks at 7d. per 1000 hanks $= 14{\cdot}39$d.

Drawing-in—

2400 ends at $5\frac{3}{4}$d. per 1000 $= 13{\cdot}8$d.

(*a*) Sketch the position of the train of wheels in any positive taking-up motion. (*b*) State the number of teeth in each wheel, and give the circumference of feed roller to place 15 picks per $\frac{1}{4}$ inch in the cloth.

(*a*) See pages 37 and 40.

(*b*) $\frac{\text{Rack wheel} \times \text{Stud wheel} \times \text{Beam wheel.}}{\text{Pinion} \times \text{Picks per } \frac{1}{4} \times \text{Change wheel} \times \text{Circumference of Feed Roller in } \frac{1}{4} \text{ inches.}}$

A train of wheels are put together, and a size of beam used, so that the numerators multiplied together will cancel the denominators multiplied together, thus the numbers are taken in the same order as the above wheels.

$$\frac{60 \times 72 \times 90}{18 \times 15 \times 24 \times 60} = 0$$

Find the quantity of warp and weft required to make the following cloth.—96 yards of cloth from 100 yards of warp, width in reed 36 inches, 80 ends per inch in reed—

WARP PATTERN—

4 ends—40's Blue.

8 ends—32's White.

11 picks per $\frac{1}{4}$ inch, 12's white weft. Allow 40 yards per hank for waste in warp and weft.—*1st year.*

WARP—

$$\frac{36 \times 80}{12 \text{ ends in a pattern}} = 240 \text{ patterns.}$$

$$\text{Blue}—\frac{4 \times 240 \times 100}{800 \times 40} = 3\text{lbs.}$$

$$\text{White—}\ \frac{8\times240\times100}{800\times32}=7{\cdot}5\text{lbs.}$$

$$\text{Weft—}\ \frac{36\times44\times96}{800\times12}=15{\cdot}8\text{lbs.}$$

What would be the cost per yard of the following cloth:—660 yards of cloth from 700 yards of warp, 36 dents per inch in reed, all the warp yarn 20's, 72 picks per inch 24's soft blue weft? Allow 40 yards per hank in warp and weft:—

Warp Pattern.

40	Blue .. in ..	20	dents.
2	Print .. in ..	1	dent.
4	Blue .. in ..	2	dents.
8	White.. in ..	2	dents.
4	Blue .. in ..	2	dents.
2	Print .. in ..	1	dent.
60	ends.	28	dents.
43	patterns + 40 Blues	43	patterns.
180		84	
240		112	
2580		1204	
40	Blue	20	
2620	ends in =	1224	dents.

2nd year.

	Cost. s.	d.	
20's Twist at	0	7	per lb.
24's Weft ..	0	7½	,,
Dyeing Blue	0	3½	,,
Printing....	0	6	,,
Bleaching ..	0	7	per bundle.
Sizing Twist	0	6	,,
Winding			
Warp ..	0	6	,,
Weft ..	0	9	,,
Warping ..	1	2	per 1000 hanks.
Section Warping	0	1	per 100yds.
Drawing-in..	0	8½	per 1000 ends.
Weaving....	2	6	per 70 yds. of warp.
Expenses ..	3	9	per 70 yds. of warp.
Finishing ..	1	6	per 66 yds. of cloth.

Weight of Warp—

$$\text{Blue—}\ \frac{48\times43\times700}{800\times20}=90{\cdot}3\text{lbs.}$$

$$\text{Print—}\ \frac{4\times 43\times 700}{800\times 20}=7{\cdot}5\text{lbs.}$$

$$\text{White—}\ \frac{8\times 43\times 700}{800\times 20}=15\text{lbs.}$$

$$\text{Blue Selvage—}\ \frac{40\times 700}{800\times 20}=1{\cdot}75\text{lbs.}$$

WEIGHT OF WEFT—

$$\frac{1224\text{ ends}}{36\text{ dents per inch}}=34\text{ inches width in reed.}$$

therefore— $\dfrac{34\times 72\times 660}{800\times 24}=84{\cdot}1\text{lbs.}$

COST—	Pence.
Warp—Total weight 114·5lbs. at 7d. per lb...	801·5
Weft— ,, 84·1lbs. at 7½d. ,, ...	630·7
Blue Warp Dyeing, 92lbs. at 3½d. ,, ...	322·
Printing, 7·5lbs. at 6d. per lb.	45·
Bleaching, 15lbs. at 7d. per bundle (10lbs.)...	10·5
Sizing Warp, 114·5lbs. at 6d. per bundle (10lbs.)	68·7
Winding Warp, 114·5lbs. at 6d. ,, ,,	68·7
Winding Weft, 84·1lbs. at 9d. ,, ,,	75·6
Section Warping, 700yds. at 1d. per 100yds....	7·
Drawing-in, 1224 ends at 8½d. per 1000 ends	10·4
Weaving 700yds. Warp at 2s. 6d. per 70yds. of Warp	300·
Finishing 660yds. Cloth at 1s. 6d. for 66yds. of Cloth	180·
Expenses 700yds. Warp, at 3s. 9d. per 70yds. of Warp	450·
	2970·1

2,970 pence cost for 700yds. of Warp, or 660yds. of Cloth; therefore, the cost per yard of Cloth equals:—

$$\frac{2970}{660} = 4{\cdot}5 \text{ pence.}$$

What would be the cost per yard of the following Zephyr check dress cloth:—96 yards of cloth, from 100 yards of warp, 30's twist, at 1/- per lb. dyed, 30 inches wide, and 88 ends per inch, 80 picks, 40's weft, at 1/2 per lb. dyed; allow 40 yards per hank in waste for warp and weft; sizing warp ½d. per lb., dressing warp 5½d. per 100 hanks, drawing-in 6d. per 1,000 ends for 500 yards of warp, winding weft 2d. per lb., weaving 3d. per pick per ¼ inch for 100 yards of warp; other expenses 1¼ times weaving; calendering and making up ¼d. per yard?

Warp and Weft Pattern—

	80 Azure.	
	4 White.	
	12 Azure.	
5 repeats	2 White.	
	2 Azure.	
2 repeats	4 White.	
	4 Blue.	
	12 White.	
	144	*3rd year.*

WEIGHT OF WARP—

Azure—

$$\frac{\text{Ends.} \quad \text{Width.} \quad \text{Ends per In.} \quad \text{Length.}}{\text{Ends in Pattern.} \quad \text{Counts.} \quad \text{Hank.}} = \frac{102 \times 30 \times 88 \times 100}{144 \times 30 \times 800} = 7{\cdot}7 \text{ lbs.}$$

White—

$$\frac{34 \times 30 \times 88 \times 100}{144 \times 30 \times 800} = 2{\cdot}6 \text{ lbs.}$$

Blue—

$$\frac{8 \times 30 \times 88 \times 100}{144 \times 30 \times 800} = {\cdot}61 \text{ lbs.}$$

WEIGHT OF WEFT—

Azure—

$$\frac{\text{Picks.} \quad \text{Width.} \quad \text{Picks per In.} \quad \text{Length.}}{\text{Picks in Pattern.} \quad \text{Counts.} \quad \text{Hank.}} = \frac{102 \times 30 \times 80 \times 96}{144 \times 40 \times 800} = 5{\cdot}1 \text{ lbs.}$$

White—

$$\frac{34 \times 30 \times 80 \times 96}{144 \times 40 \times 800} = 1{\cdot}7 \text{ lbs.}$$

Blue—

$$\frac{8 \times 30 \times 80 \times 96}{144 \times 40 \times 800} = {\cdot}4 \text{ lbs.}$$

	Pence
Warp, 10·9 lbs. at 12d. per lb.	130·8
Weft, 7·2 lbs. at 14d. per lb.	100·8
Sizing Warp, 10·9 lbs. at ½d. per lb.	5·4
Dressing Warp, 327 hanks at 5½d. per 100 hanks	17·9
Drawing-in, 2,640 ends at 6d. per 1,000 for 500 yards of warp (for 100 yards)	3·1

	Pence.
Winding Weft, 7·2 lbs. at 2d. per lb.	14·4
Weaving, 20 picks at 3d. per $\frac{1}{4}$ inch for 100 yards of Warp	60·
Expenses, $1\frac{1}{4}$ times weaving.....	75·
Calendering and making-up, $\frac{1}{4}$d. per yard	24·
	431·4

431 pence for 96 yards of cloth.

Cost per yard equals $\frac{431}{96} = 4{\cdot}48$ pence.

(*a*) What is understood by a perfectly balanced cloth? (*b*) Supposing 72 threads and picks per inch of 36's counts produced a perfectly satisfactory cloth in calico weave, how many ends and picks per inch could be put in a 2 and 2 twill weave with equal perfection. (*c*) Also what counts of yarn should be used in a calico weave with only 60 threads and picks per inch? *3rd year.*

(*a*) The ends and picks are in close contact with each other, any additional ends or picks will cause them to crush each other, and any less ends or picks will be the means of leaving spaces between them.

(*b*) The ends plus intersections in

4 ends of plain (calico) = 8.

4 ends of twill = 6.

Therefore $\frac{72 \times 8}{6} = 96$ ends and picks required.

(*c*) Square root of 36's = 6.

Therefore $\frac{6 \times 60}{72} = 5$ and $5^2 = 25$'s counts.

CITY AND GUILDS OF LONDON EXAMINATION, 1899.

(*a*) What would be the weight in grains of three hanks of 26's cotton yarn? (*b*) Also find the counts of a warp 15 yards long, containing 2560 ends, and weighing 10 ounces. *1st year.*

(*a*) $\frac{3 \times 840 \times 7000}{840 \times 26} = 807{\cdot}6$ grains.

(*b*) $\frac{2560 \times 15 \times 16 \text{ ozs.}}{840 \times 10} = 73{\cdot}1$'s counts.

What would be the cost of beam warping, and slashing for 500 pieces of cloth; 100 yards of warp per piece, 2400 ends and 24's counts, 480 ends on a beam. Rate of payment:—5d. per wrap of 3500 yards for warping and 6/- per 100 pieces of 100 yards for slashing. *1st year.*

BEAMING—

$$\frac{100 \text{ yds.} \times 500 \text{ pcs.} \times 5\text{d.} \times 2400 \text{ ends.}}{3500 \text{ yds.} \times 480 \text{ ends.}} = 357\text{d.} = \begin{array}{ccc} £ & s. & d. \\ 1 & 9 & 9 \end{array}$$

SLASHING—

$$\frac{6/- \times 500}{100} = \begin{array}{ccc} £ & s. & d. \\ 1 & 10 & 0 \end{array}$$

Find the quantity of warp and weft required to make the following cloth :—115 yards of cloth from 120 yards of warp, width in reed 32 inches, 72 ends per inch in reed—

WARP PATTERNS—

8 White 24's
2 Blue 28's
2 White 24's
2 Blue 28's
8 White 24's
2 Red 32's

24 ends in one repeat.

18 picks per $\frac{1}{4}$ inch of 24's white weft. Allow 40 yards per hank for waste in both warp and weft. *1st year.*

WARP—

$32 \times 72 = 2304$ ends in warp; the weight and number of ends each colour of warp =

White 18 patterns × 96 repeats = 1728 ends
Blue 4 „ × 96 „ = 384 „
Red 2 „ × 96 „ = 192 „

$$\text{White} — \frac{1728 \times 120}{800 \times 24} = 10{\cdot}8\text{lbs.}$$

$$\text{Blue} — \frac{384 \times 120}{800 \times 28} = 2{\cdot}05\text{lbs.}$$

$$\text{Red} — \frac{192 \times 120}{800 \times 32} = {\cdot}9\text{lbs.}$$

WEFT—

$$\frac{32 \times 72 \times 115}{800 \times 24} = 13{\cdot}8\text{lbs.}$$

What would be the cost per yard of the following Terry towelling cloth:—200 yards of cloth from 208 yards of Ground warp, and 728 yards of Terry warp, 16 inches wide in reed, 50 picks per inch of 20's cops. The warp to be beamed, and the red and white Terry threads run from bobbins when beaming. Allow 40 yards per hank waste in weft and ground warp. Ground warp 476 ends 20's grey ?

Terry Warp.	Prices.
8 Grey 3/20's	20's Yarn in Warp .....6d. per lb
6 Red 3/24's	3/20's ,, ,, ...8d. ,,
6 White 3/20's	3/24's ,, ,, ...8d. ,,
6 Red 3/24's	3/20's ,, ,, ...7¾d. ,,
150 Grey 3/20's	20's Cop Yarn .....4¾d. ,,
6 Red 3/24's	Sizing Warp ..... ¾d. ,,
6 White 3/20's	Dyeing and Sizing red.....4½d. ,,
6 Red 3/24's	Bleaching and Sizing white .....1d. ,,
8 Grey 3/20's	Winding White and Red..... ⅛d. ,,
202	Beaming 1d. per 60 yards, with 2d. per warp extra for running ends from bobbins.
	Drawing-in 1/- per 1,000 ends.
	Weaving 2/6 per 100 yards of cloth.
2nd year.	Other expenses 5/- per 100 yards of cloth.

Weight of Terry Warp—

Grey—

$$\frac{166 \text{ ends} \times 728 \times 3}{840 \times 20} = 21{\cdot}51\text{lbs.}$$

White—

$$\frac{12 \text{ ends} \times 728 \times 3}{840 \times 20} = 1{\cdot}51\text{lbs.}$$

$$\text{Red}—\frac{24 \text{ ends} \times 728 \times 3}{840 \times 24} = 2{\cdot}6 \text{ lbs.}$$

GROUND WARP—

$$\frac{476 \text{ ends} \times 208}{800 \times 20} = 6{\cdot}18 \text{ lbs.}$$

WEIGHT OF WEFT—

$$\frac{16'' \times 50 \times 200}{800 \times 20} = 10 \text{ lbs.}$$

COST—		PENCE.
20's Yarn in Warp 6·18 lbs. @ 6d. per lb.	=	37
3/20's Grey 21·5 lbs. @ 8d. per lb.	=	172
3/24's Red 2·6 ,, ,, 8d. ,,	=	20·8
3/20's White 1·5 ,, ,, $7\frac{3}{4}$d. ,,	=	11·5
20's Weft 10· ,, ,, $4\frac{3}{4}$d. ,,	=	47·5
Sizing Warp 28·7 ,, ,, $\frac{3}{4}$d. ,,	=	21·5
Dyeing and Sizing Red 2·6 lbs. @ $4\frac{1}{2}$d. per lb.	=	12·2
Bleaching and Sizing White 1·5 lbs. @ 1d. per lb.	=	1·5
Winding White and Red 4·3 lbs. @ $\frac{1}{8}$d. per lb.	=	·5
Beaming 1d. per 60 yards with 2d. per warp (728+208 yards = 936 yards)	=	15·6
extra for running ends from bobbins (728+208 yards = 936 yards)	=	2
Drawing-in 1/- per 1000 ends (678 ends)		8·1
Weaving 2/6 per 100 yards of cloth (200 yards)		60
Other expenses 5/- per 100 yards of cloth (200 yards)		120
		530·7d.

530d. is cost for 200 yards of cloth the cost per yard

$$\text{therefore} = \frac{530}{200} = 2{\cdot}65\text{d.}$$

If a plain cloth with 80 thread per inch of 36's, and 64 picks of 25's may be considered perfect in structure, (*a*) what counts of warp and weft must be used in order to make a plain cloth, equally perfect, with only 68 threads and 60 picks per inch? (*b*) also, what counts should be used if the latter particulars had to be woven in a 2 and 2 twill, instead of plain. *3rd year.*

(*a*)

$$\text{sq. rt. of } 36\text{'s} = 6. \therefore \frac{6 \times 68}{80} = 5{\cdot}1 \text{ and } 5{\cdot}1^2 = 26\text{'s warp.}$$

$$\text{sq. rt. of } 25 = 5. \therefore \frac{5 \times 60}{64} = 4{\cdot}68 \text{ and } 4{\cdot}68^2 = 21{\cdot}9\text{'s weft.}$$

(*b*)

In 4 ends of plain cloth there are 4 ends + 4 intersections = 8.

In 4 ends of 2 and 2 twill there are 4 ends + 2 intersections = 6.

$$\frac{5{\cdot}1 \times 6}{8} = 3{\cdot}8 \text{ and } 3{\cdot}8^2 = 14\tfrac{1}{2}\text{'s warp.}$$

$$\frac{4{\cdot}68 \times 6}{8} = 3{\cdot}5 \text{ and } 3\ 5^2 = 12\tfrac{1}{4}\text{'s weft.}$$

Calculate the quantity of warp and weft yarns which would be required to make 500 yards of cloth from 540 yards of warp of the following design, allowing 40 yards per hank waste both for warp and weft, 27 dents per inch in reed, 52 picks per inch.

Warp Pattern.		Weft Pattesn.
20 Blue 18's.		20 Blue 12's.
1 Grandrille composed of	1 thread 30's yellow 1 ,, 12's red. 1 ,, 20's green.	2 Grandrille $\frac{2}{40}$.
6 White 18's.		4 White 16's.
1 Girdle as above,		2 Grandrille $\frac{2}{40}$.
20 Blue 18's.		20 Blue 12's.
4 Red 20's.		4 Red 20's.
		52
52 threads in	27 dents.	
30 repeats	30	
1560 ends	810 dents.	
30 ends selvege white 18's	15 dents for selvage	
1590 ends.	825 dents	*3rd year.*

Weight and number of ends of each colour of Warp.

$$\text{Blue}—\frac{40 \text{ ends} \times 30 \text{ reps.} \times 540 \text{ yds.}}{800 \times 18\text{'s.}} = 45\text{lbs.}$$

$$\text{White}—\frac{6 \text{ ends} \times 30 \text{ reps.} \times 540 \text{ yds.}}{800 \times 18\text{'s.}} = 6{\cdot}7\text{lbs.}$$

$$\text{Red}—\frac{4 \text{ ends} \times 30 \text{ reps. } 5 \times 540 \text{ yds.}}{800 \times 20\text{'s}} = 4{\cdot}05\text{lbs.}$$

The resultant counts of 20's, 12's, and 30's = 6's.

$$\therefore \text{ Grandrille}—\frac{2 \text{ ends} \times 30 \text{ reps.} \times 540 \text{ yds.}}{800 \times 6\text{'s.}} = 6{\cdot}75\text{lbs.}$$

$$\text{White Selvege}—\frac{30 \text{ ends} \times 540 \text{ yds.}}{800 \times 18\text{'s.}} = 1{\cdot}12\text{lbs.}$$

WEFT— The width in the reed.

$$\frac{825 \text{ dents}}{27 \text{ dents per inch.}} = 30{\cdot}5''$$

$$\text{Blue—} \frac{40 \text{ picks} \times 30{\cdot}5 \times 500 \text{ yds.}}{800 \times 12} = 63{\cdot}5\text{lbs.}$$

$$\text{Grandrille—} \frac{4 \text{ picks} \times 30{\cdot}5 \times 500 \text{ yds.} \times 2}{800 \times 40} = 3{\cdot}8\text{lbs.}$$

$$\text{White—} \frac{4 \text{ picks} \times 30{\cdot}5 \times 500 \text{ yds.}}{800 \times 16} 4{\cdot}75\text{lbs.}$$

$$\text{Red—} \frac{4 \text{ picks} \times 30{\cdot}5 \times 500 \text{ yds.}}{800 \times 20} = 3{\cdot}8\text{lbs.}$$

CITY AND GUILDS OF LONDON EXAMINATION, 1900.

(1.) (*a*) What is the circumference of the reel upon which cotton yarn is wound, and how many revolutions must be given to the reel before one hank is formed? (*b*) How many pounds of 24's yarn would be required to fill 240 warper's bobbins to the extent of ten hanks each? (*c*) What length of warp could be made from this yarn, supposing the warp must contain 2160 ends? (*d*) What would be the weight per yard of warp. *1st year.*

(*a*) $1\frac{1}{2}$ yards. 560 revolutions.

(*b*) $\frac{10 \times 240 \times 840}{24 \times 840} = 100\text{lbs.}$

(*c*) $\frac{840 \times 24 \times 100}{2160} = 933$ yards.

(*d*) $\frac{100}{933} = \cdot 107$lbs. or $\cdot 107 \times 7000 = 749$ grains.

Suppose a winder, operating on 16 ends, earns an average wage of 15/- per week, and is paid 7½d. per bundle (10 lbs.) of 24's, how many winders ends will it be necessary to employ to provide a constant supply of bobbins for three warpers who are paid 7d. per 1,000 hanks, and earn an average wage of £1 per week each? Make no allowance for waste in winding. *1st year.*

The number of hanks made by a winder on 16 ends for 15/- =

$$\frac{15 \times 12 \times 10 \times 24}{7 \cdot 5} = 5760 \text{ hanks.}$$

The number of hanks required by the warpers =

$$\frac{1000 \times 3 \times 20 \times 12}{7} = 102{,}857 \text{ hanks.}$$

Therefore, number of ends required =

$$\frac{102857 \times 16}{5760} = 285 \text{ ends.}$$

Calculate the quantity of each kind of material required to make 90 yards of grandrille shirting, from 96 yards of warp. Width in reed 30 inches, 100 ends per inch in reed, 18 picks per ¼ inch of 16's cop weft. Allow 40 yards per hank waste in warp and weft.

Warp Pattern—

30 Grandrille 2/40's
3 Sky 22's
3 Indigo 20's
18 Grandrille 2/40's
3 Pink 24's
3 Red 24's

60 *1st year.*

Weight of Warp—

Grandrille— $\frac{48 \times 50 \text{ patterns} \times 96 \times 2}{800 \times 40} = 14{\cdot}4\text{lbs.}$

Sky— $\frac{3 \times 50 \times 96}{800 \times 22} = {\cdot}81\text{lbs.}$

Indigo— $\frac{3 \times 50 \times 96}{800 \times 20} = {\cdot}9\text{lbs.}$

Pink— $\frac{3 \times 50 \times 96}{800 \times 24} = {\cdot}75\text{lbs.}$

Red— $\frac{3 \times 50 \times 96}{800 \times 24} = {\cdot}75\text{lbs.}$

Weight of Weft—

$$\frac{30 \times 72 \times 90}{800 \times 16} = 15{\cdot}1\text{lbs.}$$

What would be the cost per yard of the following gauze dress goods fabric?—120 yards of cloth from 128 yards of ground warp, and 180 yards of lace warp, width in reed 33 inches, 20 dents per inch in reed, 72 picks per inch 36's bleached cop weft? Allow 40 yards per hank for waste in both warp and weft.

WARP PATTERN.

56 Sky	.. 32's	
4 White	.. 32's	
1 Sky	.. 4/20's lace	
8 White	.. 32's	
1 Sky	.. 4/20's lace	
4 White	.. 32's	
74 =		18 dents
36 repeats		36
444		108
222		54
2664		648
48 selvage		12 dents
2712 ends =		660 dents

Selvage 2/50's white.

PRICES.

	per lb.
32's Yarn for Warp	11½d.
4/20's ,, ,, lace	13d.
2/50's Selvage	12d.
36's Weft bleached	10d.
Bleaching Warp	6d. per 10lbs.
	per lb.
Dyeing Sky	3d.
Sizing Warp	1d.
Winding 32's	1d.
,, 4/20's	½d.

Warping, 12d. per 1000 hanks.
Beaming, 1d. per 100yds. warp.
Drawing-in, 10d. per 1000 ends.
Weaving, 5s. per 100yds. cloth.
Other expenses 1¾ time weaving.

2nd year.

WEIGHT OF WARP—

$$\text{Sky—}\ \frac{\text{Ends} \times \text{Repeat} \times \text{Length}}{\text{Hank Counts}} = \frac{56 \times 36 \times 128}{800 \times 32} = 10{\cdot}08\text{lbs.}$$

$$\text{White—}\ \frac{16 \times 36 \times 128}{800 \times 32} = 2{\cdot}87\text{lbs.}$$

$$\text{Sky 4 fold—}\ \frac{2 \times 36 \times 180 \times 4}{800 \times 20} = 3{\cdot}2\text{lbs.}$$

$$\text{Selvage—}\ \frac{48 \times 128 \times 2}{800 \times 50} = {\cdot}3\text{lbs.}$$

WEIGHT OF WEFT—

$$\frac{33 \times 72 \times 120}{800 \times 36} = 9{\cdot}9\text{lbs.}$$

Cost—	Pence.
32's Warp Yarn, 12·95lbs. at 11½d. per lb. ...	148·9
4/20's Warp Yarn lace, 3·2lbs. at 13d. per lb.	41·6
2/50's Selvage, ·3lbs. at 12d. per lb.	3·6
36's Weft, bleached, 9·9lbs. at 10d. per lb. ...	99·
Bleaching Warp, 2·87lbs. at 6d. per 10lbs. ...	1·7
Dyeing Sky, 13·2lbs. at 3d. per lb.	39·6
Sizing Warp, 16·5lbs. at 1d. per lb.	16·5
Winding 32's, 12·95lbs. at 1d. per lb.	12·9
Winding 4/20's, 3·2lbs. at ½d. per lb.	1·5
Warping 420 hanks, at 12d. per 1000	5
Beaming 120+180=300yds. at 1d. per 100yds.	3
Drawing-in 2712 ends, at 10d. per 1000	27·1
Weaving, 5s. per 100 yards of Cloth	72·0
Expenses, 1¾ times weaving	126·
	598·4

598 pence cost for 120 yards of Cloth; cost per yard equals $\frac{598}{120}$=4·98d.

What amount of wage would be earned for performing the following labour, viz. :—

Winding—

(*a*) 10 bundles (10lbs. each) 36's twist	}	1d. per 25 hanks.
(*b*) 10 „ „ „ 22's „		
(*c*) 10 „ „ „ 18's „		

Yorkshire Dressing—

(*a*) 2 warps, 2,600 ends, 384 yards	}	At 5d. per 100 hanks.
(*b*) 1 warp, 2,100 „ 840 „		
(*c*) 1 „ 3,224 „ 660 „		

WEAVING—

(*a*) 1 pc., 132 yds., with 60 pks. per in.
(*b*) 2 pcs., 99 ,, ,, 48 ,, ,,
(*c*) 2 ,, 88 ,, ,, 56 ,, ,,

} At 4d. per $\frac{1}{4}$ in. for 100 yards of warp.

WINDING—

	lbs.	cts.		
(*a*)	= 100	× 36	=	3,600 hanks.
(*b*)	= 100	× 22	=	2,200 ,,
(*c*)	= 100	× 18	=	1,800 ,,
				7,600 hanks.

Therefore $\frac{7600}{25}$ = 304d. × £1 5s 4d.

YORKSHIRE DRESSING—

(*a*) $\frac{2 \times 2600 \times 384}{840}$ = 2,377 hanks.

(*b*) $\frac{1 \times 2100 \times 840}{840}$ = 2,100 ,,

(*c*) $\frac{1 \times 3224 \times 660}{840}$ = 2,533 ,,

7,010 hanks.

Therefore $\frac{7010 \times 5}{100}$ = 350d. = £1 9s. 2d.

WEAVING—

(*a*) $\frac{4 \times 15 \times 132}{100}$ = 79·2d.

(*b*) $\frac{2 \times 4 \times 12 \times 99}{100}$ = 95·0d.

(*c*) $\frac{2 \times 4 \times 14 \times 88}{100}$ = 98·5d.

272·7d.

272·7 pence = £1 2s. 8$\frac{3}{4}$d.

CITY AND GUILDS OF LONDON EXAMINATIONS, 1901.

(*a*) If 4 cops from one skip weigh respectively 30, 31, 29½, and 32½ grains per wrap or lea, what is the average counts? (*b*) If we ordered warps from the spinner, 800 yards long, 920 ends, 24's counts, what would be the weight? (*c*) Also give the counts, supposing the warps were 6lbs. too light. *1st year.*

(*a*) The the total weight = 123 grains.

$$\therefore \quad \frac{4000}{123} = 32{\cdot}5 \text{ counts.}$$

(*b*) $$\frac{800 \times 920}{840 \times 24} = 36{\cdot}5\text{lbs.}$$

(*c*) The weight of the warps would be 36·5 − 6lbs. = 30·5lbs.

$$\therefore \quad \frac{800 \times 920}{840 \times 30{\cdot}5} = 28{\cdot}7\text{'s counts.}$$

What would be the cost of labour per 100 yards warp in the preparatory processes for a warp containing 3,000 ends of 24's counts, and 800 yards in length; winding warp, 7d. per 10lb. bundle; warping, 8d. per 1,000 hanks; beaming, 1½d. per 120 yards; drawing-in, 6½d. per 1,000 ends? *1st year.*

The weight of the warp equals—

$$\frac{3000 \times 800}{840 \times 24} = 119 \text{ lbs.}$$

Winding— $\frac{7 \times 119}{10} = 83{\cdot}3\text{d.} = \frac{83{\cdot}3}{8} = 9{\cdot}1\text{d. for 100 yds.}$

Warping— $\frac{119 \times 24 \times 8\text{d.}}{1000} = 22{\cdot}8\text{d.} = \frac{22{\cdot}8}{8} = 2{\cdot}8\text{d. yard}$

Beaming— $\frac{1{\cdot}5 \times 800}{120} = 10\text{d.} = 8{\cdot}3\text{d. for 100 yards.}$

Drawing-in— $\frac{6{\cdot}53 \times 3000}{1000} = 19{\cdot}5\text{d.}$

(*a*) Give three methods of counting reeds, and state the districts where they are in vogue. (*b*) If a 5-end satin warp, drawn through a reed 33 dents per inch and 4 ends in a dent, was required to be altered to an 8-end satin, woven with 3 ends in a dent, what reed would you use to bring it the same width? (*c*) Also, how would you drop the healds if you had to use 8 shafts with 18 eyes per inch on each? *1st year.*

(*a*) See pages 138 and 139 for answer.

(*b*) A reed 33 dents per inch, Stockport counts, equals a 66 reed; in the question a finer reed will be required, therefore

$$\frac{66 \times 4}{3} = 88 \text{ Reed.}$$

(*c*) The number of healds per inch required on each shaft to suit the 88 reed, 3 ends in a dent, will equal 88 × 3 ends in a dent = 264 ends on 2 inches.

$\frac{264 \text{ stitches}}{2\text{in.} \times 8 \text{ shafts}} = 16{\cdot}5$ stitches or healds on each shaft required.

In the example 18 eyes are knit on each inch per shaft, therefore $1\frac{1}{2}$ eyes are dropped per inch, or 10 on 8 shafts, the best way will be to drop 24 on 3 inches and 16 on the next inch.

Find the quantity of each colour of warp and weft required to produce 400 yards of a fine Oxford shirting. Length of warp, 430 yards; width in reed, 31¾ins.; 68 ends per inch in reed, 15 picks per ¼in. 20's cops. Allow 40 yards per hank for waste in both warp and weft.

WARP PATTERN.

24 Sky 18's.
2 Blue 2/40's.
2 White 2/40's.
2 Blue 2/40's.
24 Sky 18's.
6 White 2/40's.
2 Blue 2/40's.
6 White 2/40's.

70 × 30 repeats + 24 sky; and 32 white 2/40 selvage.
Total ends 2156. *1st year.*

WEIGHT OF WARP—

$$\text{Sky} — \frac{48 \times 30 \times 430}{800 \times 18} = 43\text{lbs.}$$

$$\text{Blue} — \frac{6 \times 30 \times 430 \times 2}{800 \times 40} = 4{\cdot}8\text{lbs.}$$

$$\text{White} — \frac{16 \times 30 \times 430 \times 2}{800 \times 40} = 12{\cdot}9\text{lbs.}$$

$$\text{Selvage—Sky} \frac{24 \times 430}{800 \times 18} = {\cdot}71\text{lbs.}$$

$$\text{,, White—} \frac{32 \times 430 \times 2}{800 \times 40} = {\cdot}86\text{lbs.}$$

WEFT. $$\frac{31{\cdot}75 \times 60 \times 400}{800 \times 20} = 47{\cdot}6\text{lbs.}$$

Calculate the cost per dozen tapestry table-cloths, 68ins. wide in reed, 84ins. long.

Warps.	Weft.
Binding warp, 900 ends 2/60 Black.	60 picks per inch, 6's weft, Slate and Maroon alternate picks of each.
No. 1 warp, 5,400 ends 2/40 Fawn.	
No. 2 warp, 5,400 ends 2/40 Gold.	

Cost of grey yarn 2/60's=1s. 2d. per lb., 2/40's=1s. per lb., 6's weft 6d. per lb.

Dyeing and Sizing Black 6d. per lb., Fawn 4d. per lb., Gold 4½d. per. lb.

Dyeing Slate weft 3d. per lb., Maroon 4d. per lb.

Beaming warps 2d. per 100 yards, winding weft ¼d. per lb., weaving 5s. per dozen.

Expenses, including gaiting, one-and-a-half times weaving. Allow 40 yards per hank waste of weft, 5 per cent. take up of 2/40's warp, and 10 per cent. binding warp. *2nd year.*

Weight of Warp—

Binding Warp—

Black—

$$\frac{\underset{\text{Ends.}}{900} \times \underset{\text{Length.}}{84} \times \underset{\text{No. of Pieces.}}{12} \times \underset{\text{Fold.}}{2}}{\underset{\text{Hank.}}{840} \times \underset{\text{Counts.}}{60} \times \underset{\text{Inches.}}{36}} = 1 \text{ lb.}$$

Plus 10 per cent. equals 1·1 lbs.

Fawn—

$$\frac{5400 \times 84 \times 12 \times 2}{840 \times 40 \times 36} = 9 \text{ lbs.}$$

Plus 5 per cent. equals 9·45 lbs.

Gold—Same particulars and weight as the Fawn warp 9·45 lbs.

Weight of Weft—

$$\frac{68 \times 60 \times 84 \times 12}{800 \times 6 \times 36} \times 23{\cdot}8 \text{ lbs.}$$

Cost.	Pence.
Grey Yarn 1·1 lbs. 2/60's 14d. per lb.	15·4
„ „ 18·9 „ 2/40's 12d. „	226·8
Weft 23·8 lbs. 6's 6d. per lb.	142·8
Dyeing and Sizing Black 1·1 lbs. 6d. per lb.	6·6
„ „ Fawn 9·45 lbs. 4d. „	37·8
„ „ Gold 9·45 lbs. 4½d. „	42·5
Dyeing Slate weft 11·9 lbs. 3d. per lb.	35·7
„ Maroon „ 11·9 lbs, 4d. „	47·6
Beaming warps 28 yards at 2d. per 100 yards ...	·5
Winding Weft 23·8 lbs. at ¼d. per lb.....	5·9
Weaving 5/- per dozen pieces	60·0
Expenses one-and-a-half times weaving 7/6	90·0
711·6d. = £2 19s. 3d.	711·6

(*a*) How long will it take to weave a piece of cloth 70 yards long with 56 picks per inch, if we have 10½-in. pulleys on loom driven from a 16-in. drum on line shaft making 120 revolutions per minute, and the stoppages

occupy one-third of the time? (*b*) Also, what pinion would be required to put in the required picks, if the motion has a ratchet wheel 50 teeth, stud wheel 120 teeth, cloth roller wheel 75 teeth, stud wheel pinion 15 teeth, and a feed roller 15 ins. circumference. *2nd year.*

(*a*) In 70 yards of cloth the picks required equals $70 \times 36 \times 56 = 141{,}120$.

The speed of the loom equals $\frac{16 \times 120}{10{\cdot}5} = 182{\cdot}8$ pks *less* $\frac{1}{3}$ for stoppages $182{\cdot}8 - 60{\cdot}9 = 122$ nearly.

Time required—$\frac{141120}{122} = 19$ hours 16 minutes.

(*b*) $\frac{50 \times 120 \times 75}{15 \times 60 \times 14} = 35{\cdot}7$ is the nearest number, but a fractional part of a tooth cannot be used in a change wheel.

(*a*) If 80 threads and picks of 20's twist and weft are considered to produce a perfect fabric when woven by 2 and 2 twill, how many threads and picks would you use for a 3 up 3 down 1 up 1 down 1 up 1 down twill? (*b*) Also if woven plain calico. (*c*) If you desired to change the counts instead of the weave, what counts would you adopt in each case? (*d*) Upon what principle is a perfect structure of cloth based. *3rd year.*

(*a*) In one repeat of the 2 and 2 twill there will be 4 ends + 2 intersections = 6.

In the other twill 10 ends + 6 intersections = 16.

Both patterns must be carried to 20 ends each.

The number of ends plus intersections in each one will then be

2 and 2 twill: 20 ends + 10 intersections = 30.

The other twill: 20 ends + 12 intersections = 32.

Therefore $\frac{80 \times 30}{32} = 75$ ends and picks required.

(*b*) In 4 ends twill there are 4 ends + 2 intersections = 8.

In 4 ends plain there are 4 ends + 4 intertections = 8.

Therefore $\frac{80 \times 6}{8} = 60$ ends and picks.

(*c*) The square root of 20's = 4·47.

Therefore in (*a*) $\frac{4{\cdot}47 \times 80}{57} = 4{\cdot}76$ and $4{\cdot}76^2 = 22{\cdot}6$'s.

(*c*) $\frac{4.47 \times 80}{60} = 5{\cdot}96$ and $5{\cdot}96^2 = 35{\cdot}5$'s.

(*d*) See page 28.

What would be the cost per yard for 10,000 yards of cloth from 10,500 yards of warp, of the following check fabric, other costs beside those mentioned to be covered by a sum equal to one and a quarter times cost of actual weaving:

Warp Pattern—

			s.	d.	
	24 Pink 30's	Twist at	1	2	per lb.
	6 White 40's	,,	1	3	,,
2	2 Sky 2/40's	,,	0	11	,,
	2 White 40's	,,	1	3	,,
	4 Pink 30's	,,	1	2	,,
	6 White 40's	,,	1	3	,,
	48				

To be checked same pattern as warp, but all 40's weft at 1/1 per lb. for colour, and 11d. per lb. for white; 36 inches wide, and 76 ends per inch in reed, 72 picks per inch. Winding warp 1d. per 25 hanks; winding weft 1d. per 18 hanks; warping 10d. per 1000 hanks; weaving 3d. per pick per $\frac{1}{4}$ inch for 105 yards of warp, *3rd year.*

Weight of Warp—

$$\frac{36 \times 76}{48} = 57 \text{ Repeats.}$$

$$\text{Pink—}\frac{28 \times 57 \times 10500}{840 \times 30} = 665 \text{ lbs.}$$

$$\text{White—}\frac{16 \times 57 \times 10500}{840 \times 40} = 285 \text{ lbs.}$$

$$\text{Sky—}\frac{4 \times 57 \times 10500 \times 2}{840 \times 40} = 142 \text{ lbs.}$$

Total Weight of Weft—

$$\frac{36 \times 72 \times 10000}{840 \times 40} = 771 \text{ lbs.}$$

The proportionate weights of each colour of weft are—

$$\text{Pink}—\frac{771 \times 28}{48} = 450\text{lbs.}$$

$$\text{White}—\frac{771 \times 16}{48} = 257\text{lbs.}$$

$$\text{Sky}—\frac{771 \times 4}{48} = 64\text{lbs.}$$

Cost—					Pence
Pink Warp, 665lbs.	at	14d.	per	lb.	9310
White ,, 285	,,	15d.	,,	.....	4275
Sky ,, 142	,,	11d.	,,	.....	1562
Weft, colour 514	,,	13d.	,,	.....	6682
,, white 257	,,	11d.	,,	.....	2827
Winding Warp, 34,190 hanks	at	1d.	per	25 hanks	1367
,, Weft, 30,840	,,	1d.	,,	18 ,,	1713
Warping 34,190 hanks	at	10d.	per	1000 ,,	341
Weaving 18 picks per $\frac{1}{4}$ inch at 3d. per $\frac{1}{4}$ inch for 105 yards of Warp (10,500)					5400
Expenses $1\frac{1}{4}$ times weaving.....					6750
					40,227

$$\text{Cost per yard}—\frac{40227}{10000} = 4{\cdot}0227\text{d.}$$

CITY AND GUILDS OF LONDON EXAMINATION, 1902.

(*a*) What is understood by the "counts" of cotton yarn? (*b*) What is the system of counting yarn below 1's, and by what name is it known? (*c*) Give the weight in grains of a lea of 24's, 28's, 38's, and 44's. *1st year.*

(*a*) By "counts" is meant the number of hanks per lb.

(*b*) The "Hank System"; thus ·5 hank means half of 1's counts.

(*c*) $\frac{1000}{24} = 41{\cdot}6$ Grs. $\quad \frac{1000}{28} = 35.7$ Grs. $\quad \frac{1000}{38} = 26{\cdot}3$ Grs. $\quad \frac{1000}{44} = 22{\cdot}7$ Grs.

If you required a warp containing 2,000 ends of 24's indigo blue, 800 yards long, which would be the least expensive way to produce it of the two following:—(*a*) By Yorkshire dressing, at 4d. per cut of 70 yards for 1,200 ends, and an additional ½d. per cut for every 100 ends over 1,200; (*b*) by winding, warping, and beaming, at 7d. per 10lb. bundle for winding; 7d. per 1,000 hanks for warping, and 1d. per 90 yards for beaming? Name any other particulars besides wages which you think ought to be taken into consideration. *1st year.*

(*a*) At 4d. per cut, 1,200 + ½d. per 100 ends = 8d per 2,000 ends.

$$\frac{8\text{d.} \times 800 \text{ yds.}}{70 \text{ yds.}} = 91{\cdot}4 \text{ pence.}$$

(*b*) Beaming— $\frac{7d. \times 2000 \times 800}{10 \times 840 \times 24} = 55{\cdot}5$ pence.

Warping— $\frac{7d. \times 2000 \times 800}{100 \times 840} = 13{\cdot}3$ pence.

Beaming— $\frac{1d. \times 800}{90} = 8{\cdot}8$ pence.

77·6 pence.

Find the quantity of each colour of warp and weft required to produce 760 yards of Sateen Skirting. Length of warp, 800 yards; width in reed, 32 inches; 120 ends per inch in reed; 16 picks per $\frac{1}{4}$ inch; 24's sized blue weft. Allow 40 yards per hank for waste in both warp and weft.

Warp Pattern—

80	blue	24's counts.
5	red	,, ,,
10	blue	,, ,,
5	red	,, ,,
20	blue	,, ,,
20	orange	2/40's ,,
20	blue	24's ,,
5	red	,, ,,
10	blue	,, ,,
5	red	,, ,,
80	blue	,, ,,
10	white	2/40's ,,
20	blue	24's ,,
5	white	2/40's ,,

10	blue	24's	counts.
5	white	2/40's	,,
10	blue	24's	,,
5	white	2/40's	,,
10	blue	24's	,,
5	white	2/40's	,,

340×11 repeats + 60 blue and 40 selvage 2/40's white.

Total ends, 3,840. *1st year.*

WEIGHT OF WARP—

Blue— $\dfrac{3030 \text{ ends} \times 800 \text{ yds.}}{800 \times 24\text{'s cts.}} = 126{\cdot}2\text{lbs.}$
yds. hank

Red— $\dfrac{220 \text{ ends} \times 800 \text{ yds.}}{800 \times 24\text{'s cts.}} = 9{\cdot}2\text{lbs.}$
yds. hank

Orange— $\dfrac{220 \text{ ends} \times 800 \text{ yds.} \times 2 \text{ fold}}{800 \times 40\text{'s cts.}} = 11\text{lbs.}$
yds. hank

White— $\dfrac{330 \text{ ends} \times 800 \text{ yds.} \times 2 \text{ fold}}{800 \times 40\text{'s cts.}} = 16{\cdot}5\text{lbs.}$
yds. hank

Selvege— $\dfrac{40 \text{ ends} \times 800 \text{ yds.} \times 2 \text{ fold}}{800 \times 40\text{'s cts.}} = 2\text{lbs.}$
yds. hank

WEIGHT OF WEFT—

$$\frac{32'' \text{ wid.} \times 64 \text{ pks.} \times 760 \text{ yds.}}{800 \times 24\text{'s cts.}} = 81\text{lbs.}$$
yds. hank

What would be the cost per yard of the following Oxford shirting cloth:—760 yards cloth from 800 yards warp, width in reed 33 ins. 30 dents per inch in reed, 40 picks per inch, with extra picks crammed in, as per checking pattern. Allow 40 yards per hank for waste in both warp and weft.

Warp Patterns.		Weft Pattern.
48 White 40's = 12 dents		
36 White 40's = 12 ,,		32 White 12's
4 Sky 40's = 1 ,,		2 Sky 32's = 1
12 White 40's = 3 ,,		4 White 12's
4 Sky 40's = 1 ,,		2 Sky 32's = 1
20 White 20's = 10 ,,		16 White 12's
4 Sky 40's = 1 ,,		2 Sky 32's = 1
12 White 40's = 3 ,,		4 White 12's
4 Sky 40's = 1 ,,		2 Sky 32's = 1
144	44	64 = 60 picks in 1½ ins.
22 repeats	22 repeats	
288	88	
288	88	
3168	968	
66 selvage white	22 dents for selvage.	
3234 20's.	990	

Prices.

40's White warp, bleached and sized.....1s. 2d. per lb.
40's Sky ,, dyed ,, ,, ...1s. 4d. ,,
20's White ,, bleached ,, ,, ... 11d. ,,
12's White rove bleached..... 10d. ,,
32's Sky weft dyed.....1s. 0d. ,,

Winding 40's warp.....1s. 2d. per 10lb. bundle.
„ 20's „ ..... 6½d. „ „
„ 12's weft ..... 5d. „ „
„ 32's „ .....1s. 0d. „ „
Warping ..... 10d. per 1000 hanks.
Beaming warp..... 3d.
Drawing-in ..... 8d. per 1000 ends.
Weaving .....3s. 2d. for 100 yds. cloth.
Other expenses—1¼ times weaving. *2nd year.*

WEIGHT OF WARP—

White— $\frac{2376 \text{ ends} \times 800 \text{ yds.}}{40\text{'s} \times 800} = 59{\cdot}4 \text{ lbs.}$

Sky— $\frac{352 \times 800}{40\text{'s} \times 800} = 8{\cdot}8 \text{ lbs.}$

White— $\frac{440 \times 800}{20\text{'s} \times 800} = 22 \text{ lbs.}$

Selvage— $\frac{66 \times 800}{20 \times 800} = 3{\cdot}3 \text{ lbs.}$

WEIGHT OF WEFT—

White— $\frac{33 \text{ width} \times 56 \text{ picks} \times 760 \text{ yds.}}{800 \times 12\text{'s} \times 1{\cdot}5 \text{ inches}} = 97{\cdot}6 \text{ lbs.}$

yds. hank space for 58 picks.

Sky— $\frac{33 \times 8 \times 760}{800 \times 32\text{'s} \times 1{\cdot}5''} = 5{\cdot}2 \text{ lbs.}$

COST.	Pence.
40's White warp, 59·4 lbs., bleached and sized, 14d. per lb.	831
40's Sky warp, 8·8 lbs., dyed and sized, 16d. per lb.	140
20's White warp, 25·3 lbs., bleached and sized, 11d. per lb.	278
12's White rove weft, 97·6 lbs., bleached, at 10d. per lb.....	97
32's Sky weft, dyed, 5·2 lbs., at 12d. per lb., ...	62

	Pence.
Winding 40's warp, 59·4 lbs., at 14d. per bundle of 10 lbs. .	83
,, 20's warp, 25·3 lbs., at 6½d. ,, ,, ..	16
,, 12's weft, 97·6 lbs., at 5d. ,, ,, ..	48
,, 32's weft, 5·2 lbs., at 12d. ,, ,, ..	6
Warping 3234 hanks at 10d. per 1000 hanks.....	32
Beaming warp, 3d.	3
Drawing-in 3234 ends at 8d. per 1000.....	25
Weaving 760 yards at 38d. per 100 yards	288
Other expenses, 1¼ times weaving	360
	3148

Cost per yard: $\frac{3148}{760}$ = 4·1 pence.

Calculate the cost per yard of 1,000 yards of cloth from 1,050 yards of warp of the following check fabric, other costs besides those mentioned to be covered by a sum equal to 1¼ times the cost of the actual weaving.

WARP PATTERN.

16 light blue, 2 in a dent, 30's twist, at 1/3 per lb. for yarn, dye and size.

1 fancy 3-fold grandrille, in one dent, composed of
- 1 thread of 30's yellow at 1/2 per lb. for yarn, dye and size;
- 1 thread of 20's white at 1/- per lb. for yarn, dye and size;
- 1 thread of 24's red at 1/1 per lb. for yarn, dye and size,

4 light blue, as above,
1 fancy 3-fold, as above,
16 light blue, as above,
6 white, 2 in a dent, 36's, at 1/3 per lb. for yarn, bleach and size,
4 pale sky, 3 in a dent, 30's, at 1/3 per lb. for yarn, bleach and size,
8 white, as above,

58 = 30 dents.

To be checked same pattern as warp but all 40's weft at 1/1 per lb. for colour; 11d. per lb. for white; and 2 picks of 40's red and white print at 1/4 per lb. in place of 1 thread of grandrille; 36ins. wide and 60 ends per inch in reed; 60 picks per inch; winding warp 1d. for 25 hanks; winding weft 1d. for 18 hanks; warping 10d. per 1000 hanks; weaving 3d. per pick per $\frac{1}{4}$in. for 105 yards of warp. *3rd year.*

Weight of Warp—

In the warp a 60 reed is used with 58 ends in 30 dents, therefore the number of ends in the warp equals 58 ends per inch × 36ins. wide = 2088 ends. The weight of the different colours will be in proportion to the number of ends of each colour, thus—

Light blue —$\frac{2088 \times 36 \text{ light blue} \times 1050\text{yds.}}{58 \times 30\text{'s cts.} \times 840} = 54\text{lbs.}$

Fancy—

This thread is made from 30's. 20's and 24's twisted together, the counts of the 3-fold thread will therefore equal—

$$\frac{1000}{30} = 33{\cdot}3\text{grs.}$$

$$\frac{1000}{20} = 50{\cdot}\text{ grs.}$$

$$\frac{1000}{24} = \frac{41{\cdot}7\text{ grs.}}{125{\cdot}0\text{ grs}} \Big) \underline{1000} \Big(\underline{1000} \Big(\text{8's counts 3-fold}$$

therefore $\frac{2088 \times 2 \text{ ends} \times 1050}{58 \times 8\text{'s cts.} \times 840} = 11{\cdot}25\text{lbs.}$

White— $\frac{2088 \times 16 \text{ ends} \times 1050}{58 \times 36 \times 840} = 20\text{lbs.}$

Pale sky— $\frac{2088 \times 4 \text{ ends} \times 1050}{58 \times 30\text{'s} \times 840} = 6\text{lbs.}$

WEIGHT OF WEFT—

The weft is all the same counts and the total weight is—

$$\frac{36\text{ins. wide} \times 60 \text{ picks} \times 1000 \text{ yds.}}{840 \times 40\text{'s cts.}} = 64{\cdot}2\text{lbs}$$

The weight of each colour is in proportion to the number of picks in the pattern of each colour—

Light blue— $\frac{64{\cdot}2\text{lbs.} \times 36 \text{ L. blue picks}}{60 \text{ picks in pattern}} = 38{\cdot}6\text{ lbs.}$

Red and white— $\frac{64{\cdot}2 \times 4}{60} = 4{\cdot}3\text{lbs.}$

White— $\frac{64{\cdot}2 \times 16}{60} = 17{\cdot}2\text{lbs.}$

Pale sky— $\frac{64{\cdot}2 \times 4}{60} = 4{\cdot}3\text{lbs.}$

COST—	Pence.
Warp—Light blue, 54lbs. at 1/3 per lb.	= 810
Fancy Grandrille, 11·25lbs. at 12·77d. per lb	= 143
White, 20lbs. at 1/3 per lb.	= 300
Pale sky, 6lbs. at 1/3 per lb.	= 90
Weft— Light blue, 38·6lbs. at 1/1 per lb.	= 501
Pale sky, 4·3lbs. at 1/1 per lb.	= 56
White, 17·2lbs. at 11d. per lb.	= 189
Red and white print, 4·3lbs. at 1/4 per lb.	= 68
Winding warp, 2,610 hanks at 1d. per 25 hanks	= 104
Winding weft, 2,568 hanks at 1d. per 18 hanks	= 142
Warping 2,610 hanks at 10d. per 1,000 hanks	= 26
Weaving 1,050 yds., 15 picks, at 3d. per pick per 105 yds.	= 450
Expenses, $1\frac{1}{4}$ times cost of weaving	562
	3441

Cost per yard— $\frac{3441}{1000} = 3{\cdot}4$ pence.

CITY AND GUILDS OF LONDON EXAMINATION, 1903.

(*a*) If you had to make a warp containing 4000 ends, how many yards could you make from 200 warping bobbins if each contained $\frac{1}{2}$lb. of 32's yarn? (allow 40 yards per hank for waste and yarn left on bobbins). (*b*) What do you understand by the terms "counts," (*c*) "bundle," (*d*) "hank," and (*e*) "cross-reeled," as applied to cotton yarn? 1*st year*.

(*a*) The weight of yarn = 100 lbs.,

therefore $\frac{100 \text{ lbs.} \times 32\text{'s} \times 840}{4000 \text{ ends.}} = 672$ yards.

(*b*) The number of hanks to the lb.

(*c*) Yarn for export is generally made up into 10-lb. and 5-lb. bundles.

(*d*) A hank of cotton yarn is 840 yards.

(*e*) When the yarn is wound into hank and a quick traverse motion is used, it is wound in a crossed condition—the object is to prevent entanglement in re-winding.

(*a*) A cop is known to contain 480 yards of yarn and there are 42 to a lb. What is the counts?

(*b*) If $7\frac{1}{2}$ lbs. of waste was made out of a case of cops weighing 240 lbs., what would be the percentage of waste?

(*c*) A warp before sizing weighed 80 lbs. and after sizing 95 lbs. What percentage of size has been added? 1*st year*.

(*a*) $\frac{480 \times 42}{840} = 24$'s.

(*b*) $\frac{7{\cdot}5 \times 100}{240} = 3{\cdot}1$ per cent.

(*c*) $\frac{15 \times 100}{80} = 18{\cdot}75$ per cent.

(*a*) A warp containing 1,720 ends 420 yards long, is is to be made on a Ball warping mill 18 yards in circumference. Supposing 200 bobbins are put in the creel, how many journeys must the heck make, and how many revolutions in each direction must the mill make, also what length of yarn will be taken from each bobbin? 1*st year*.

(*a*) 1720 ends, 200 bobbins,

therefore $\frac{1720}{200} = 8$ layers + 120 ends,

therefore, there will be 8 layers of 200 ends and 1 layer of 120 ends, 80 ends being broken out for the ninth layer, the heck will therefore make 4 journeys up and 5 journeys down.

The number of revolutions $= \frac{420}{18} = 23{\cdot}3$.

The length of yarn from each of the 200 bobbins for the first 8 layers $= 420 \times 8 = 3{,}360$ yards, and for the ninth layer and extra 420 yards is wound from each of 120 bobbins.

If you had a crank shaft pinion with 20 teeth and a tappet wheel with 120 teeth, what compound carrier would be required to give the correct driving for a 8 shaft satin tappet? 1*st year*.

The picks to the round multiplied by drivers = driven wheel required, and driven wheel gives the driver required, or any ratio of these two numbers;

therefore $20 \times 8 = 160$ driven 16 32

or

120 driver 12 24

Find the quantity of yarn and amount of each colour required to produce 25 pieces of cloth, 120 yards long, from 128 yds. warp, 24's warp, 2,400 ends, 40 ins. wide in reed, 15 picks per $\frac{1}{4}$ in., 20's cops.

(*a*) 5 pieces, warp patterns, all blue.

(*b*) 5 ,, ,, ,, 8 white, 8 blue.

(*c*) 5 ,, ,, ,, 12 ,, 8 ,,

(*d*) 5 ,, ,, ,, 2 ,, 6 ,,

(*e*) 5 ,, ,, ,, 3 ,, 1 ,,

(*f*) All to have 16 ends, 2/36's white for selvage, at each side. Allow 40 yards per hank for waste in both warp and weft. *1st year.*

(*a*) $\frac{\text{Ends. Yds.}}{2400 \times 128 \times 5 \text{ pcs.}}{800 \times 24} = 80\text{lbs.}$

(*b*) 40lbs. white, 40lbs. blue.

(*c*) $12 \div 8 = 20 \therefore \frac{80}{20} = 4$

and $12 \times 4 = 48$lbs. white; $8 \times 4 = 32$lbs. blue.

(*d*) $2 + 6 = 8 \therefore \frac{80}{8} = 10$

and $10 \times 2 = 20$lbs. white; $10 \times 6 = 60$lbs. blue.

(*e*) $3+1=4 \therefore \frac{80}{4}=20$

and $20 \times 3 = 60$lbs. white; $20 \times 1 = 20$lbs. blue.

(*f*) $\frac{32 \times 128 \times 25 \times 2}{800 \times 36} = 7{\cdot}11$lbs.

Weight of Weft— $\frac{40 \times 60 \times 120 \times 25}{800 \times 20} = 450$lbs.

Suppose I desire to make a double yarn equal to 12's, and I have 180lbs. of 36's; what counts must I twist with it, and what weight will be required so that all the 36's may be used up. *2nd year.* The counts required to twist with 36's to equal—

$$12\text{'s} = \frac{1000}{12} = 83{\cdot}33 \text{ grs.} \quad \frac{1000}{36} = 27{\cdot}77 \text{ grs.}$$

and the difference between the two weights = 55·56 grs., therefore $\frac{1000{\cdot}00}{55{\cdot}56} = 18$'s counts required.

In 180lbs. of 36's there are $36 \times 180 = 6480$ hanks, therefore 6480 hanks of 18's will be required, which equals— $\frac{5480}{18} = 360$lbs.

If a lay-over Jacquard harness, 384 hooks to the repeat, was weaving a design four inches square (*a*) State in detail what arrangements you would make in order to produce the design in approximately the same size, with 80 threads per inch in reed (*b*) Also what would you do if required to make the design six inches square in the reed, with 64 threads per inch. *2nd year.*

(*a*) 384 ends on four inches $= \frac{384}{4} = 96$ reed,

If a 80 reed is used, part of the harness will be dropped and the hooks left idle; therefore to find the hooks to use.

$$\frac{384 \times 80}{96} = 320 \text{ hooks to use.}$$

(*b*) In this case the figure is required to occupy a space of six inches square; an expanding comber board on Devoge's principle must be used, expanded so that 384 ends stand on six inches, then use a 64 reed and 64 picks per inch.

Find the cost per yard for the following matting shirting cloth:—

500 yards cloth. Reed, 36 dents per inch.

$32\frac{1}{2}$ ins. wide in reed $=$ { 32 ins. 3 ends in a dent, two 24's and one 40's. / $\frac{1}{2}$ in. for selvage 2/40's.

15 picks per $\frac{1}{4}$ in. 20's soft white weft.

Warp Pattern—

No. 1 beam 520 yards.		No. 2 beam 540 yards.
4 Blue	24's	1,152 ends 40's White
4 White	24's	36 selvage 2/40's White
4 Blue	24's	
24 White	24's	1,188
36		
64 repeats		
144		
216		
2,304 ends.		Allow 40 yards for waste in warp and weft.

PRICES—

24's warp, 8d. per lb.
40's warp, 11½d. per lb.
2/40 selvage, 10d. per lb.
20 weft, 7d. per lb.
Bleaching warp and weft, 8d. per bundle.
Dyeing blue, 3d. per lb.
Sizing, 7d. per bundle.
Winding warp, 1d. per 30 hanks.
Winding weft, 1d. per 20 hanks.
Warping, 8d. per 1,000 hanks.
Beaming, 1d. per 100 yards.
Drawing, 7d. per 1,000 ends.
Weaving, 3d. per pick per ¼ in. for 100 yards cloth.
Finishing, ⅛d. per yard.
Expenses, 1¼ times the weaving price. *2nd year.*

WARP—

No. 1 Beam. White warp.

$$\frac{1792\times520}{800\times24} = 48{\cdot}5\text{lbs. or } 1166 \text{ hanks.}$$

No. 1 Beam. Blue warp.

$$\frac{512\times520}{800\times24} = 13{\cdot}86\text{lbs. or } 232 \text{ hanks.}$$

No. 2 Beam. White warp.

$$\frac{1152\times540}{800\times40} = 19{\cdot}4\text{lbs. or } 776 \text{ hanks.}$$

No. 2 Beam. Selvage.

$$\frac{36\times540\times2}{800\times40} = 1{\cdot}22\text{lbs. or } 24{\cdot}4 \text{ hanks.}$$

WEFT— $\dfrac{32{\cdot}5\times60\times500}{800\times20} = 60{\cdot}9\text{lbs. or } 1218 \text{ hanks.}$

Cost—

	Pence.
24's Warp, 62·3lbs., at 8d. per lb.	498·4
40's Warp, 19·4lbs., 11½d. per lb.	223·1
2/40's Selvage, 1·22lbs., 10d. per lb.	12·2
20's Weft, 60 9lbs., 7d. per lb.	426·
Bleaching Warp and Weft, 130lbs., at 8d. per 10lb. bundle	104·
Dyeing Blue, 13 86lbs., at 3d per lb.	41·
Sizing 83lbs., at 7d. per 10lb. bundle	58·
Winding Warp, 1d. per 30 hanks, 2198 hanks	73·
Winding Weft, 1d. per 20 hanks, 1218 hanks	60·
Warping, 8d. per 1000 hanks, 2198 hanks	17·
Beaming, 1d. per 100 yards, 540 yards	5·4
Drawing, 7d. per 1000 ends, 3492 ends	24·5
Weaving, 3d. per pick per ¼ in., for 100 yards of cloth	225·
Finishing, ⅛d. per yard, 500 yards	62·
Expenses, 1¼ times weaving	281
Cost per yard—$\frac{2110}{500} = 4{\cdot}2$ pence.	2110·6

(*a*) A sample length of grey cloth weighs 4 ounces to the yard. Supposing you have made similar cloth before and found that 20lbs. of grey cloth weighed 18lbs., after bleaching, what weight would you make the sample? (*b*) In analysing cloth, how would you gauge the counts, nature and quality of the yarn requisite for its production? (*c*) Also ascertain the price per lb. resulting, count and weight of each separate thread in 120lbs. of 3-fold yarn composed of 60's at 1s. 4d. per lb., 30's at 10d. per lb., 20's at 6d. per lb.; cost of doubling 1¼ per lb. *3rd year.*

(*a*) Assuming that 20 lbs. of cloth lost 2lbs. in finishing and bleaching, that is equal to 10 per cent. and the cloth was made 4 ounces to the yard, if it is desired to make a cloth to weigh 20lbs. for a given length, the samples must be made 10 per cent. heavier, namely 4·4 ounces per yard.

(*b*) A ready method of gauging counts is to take out as much length of yarn as possible from the sample, then weigh it and test in the usual way. Another method is to compare the threads, with standard threads of known counts.

(*c*) The cost of the three-fold thread per lb. equals—

60's at (the price of 30's) 10d. =	600
30's at (the price of 60's) 16d. =	480
90	1080

therefore— $\frac{1080}{90} = 12\text{d.}$

and the resultant counts of 60's and 30's equals—

$$\frac{1000}{60} = 16{\cdot}6\text{grs.}$$

$$\frac{1000}{30} \quad 33{\cdot}3\text{grs.}$$

$$49{\cdot}9\text{grs.}$$

therefore— $\frac{1000}{49{\cdot}9} = 20\text{'s two fold.}$

Also 20's two-fold at 12d. per lb. is twisted with 20's at 6d. per lb.; the price of the three-fold thread equals—

20's at 6d. = 120
20's at 12d. = 240

40 360

therefore— $\frac{360}{40} = 9$d. per lb.

plus $1\frac{1}{4}$d. per lb. for doubling equals $10\frac{1}{4}$d. per lb. for the three-fold thread.

The resultant counts of 20's and 20's equal 10's, the counts of the three-fold.

In 120lbs. of 10's there are 1,200 hanks; the weight of each count will therefore equal—

$\frac{1200}{60} = 20$lbs. of 60's.

$\frac{1200}{30} = 40$lbs. of 30's.

$\frac{1200}{20} = 60$lbs. of 20's.

8. Ascertain the average cost per yard of the following range of three patterns of Harvard shirting, based upon prices and particulars as given below, all to be woven in a reed with 38 dents per inch, 31 ins. wide in reed, 68 picks per inch of 16's bleached rove weft. Do not make any allowance for waste.

PATTERN 1 STRIPE.

	Ends in each dent.		Counts.
24 Blue	2	...	25
4 White	2	...	24
4 Red	4	...	2/80
4 White	2	...	24
24 Blue	2	...	24
4 White	2	...	24

64 ends in 31 dents.

PATTERN 2 STRIPE.

	Ends in each dent.		Counts.
44 Blue	2	...	24
4 White	2	...	24
4 Sky	2	...	24
4 Red	4	...	2/80
4 Sky	2	...	24
4 White	2	...	24

64 ends in 31 dents.

PATTERN 1 STRIPE.

	Ends in each dent.		Counts.
24 White	2	...	24
4 Sky	2	...	24
4 Blue	4	...	2/80
4 Sky	2	...	24
24 White	2	...	24
4 Blue	2	...	24

64 ends in 31 dents.

24's twist, 9d. per lb.; 2/80 twist, 1s. 8d. per lb.; 16's weft, 7d. per lb.; dyeing blue, 3½d. per lb.; sky, 2d. per lb.; red, 5d. per lb.; bleaching, ¾d. per lb.; sizing warp, ½d. per lb.

Preparing warp, any method, 1d. for 20 hanks.

Winding weft, 1d. for 20 hanks.

Weaving and other expenses allow 4d. per pick per ¼ inch for 100 yards of warp. (35.)

$$\frac{31'' \text{ wide} \times 38 \text{ dents per inch}}{31 \text{ dents in pattern}} = 38 \text{ patterns or stripes in each sample.}$$

To enable an estimate to be made of the average cost per yard, 100 yds. will be taken as a basis, allowing 10% for warp length.

Colours of Warp—Red, White, Blue and Sky.

The colours in the WARP are—Red, White, Blue, Blue (2 fold) and Sky, and the respective weights—

Red— $\frac{\text{ends. patterns. yds.}}{8 \times 36 \times 110 \times 2\text{-fold}}{840 \times 80\text{'s}} = 1\text{lb. nearly.}$

White— $\frac{68 \times 38 \times 110}{840 \times 24} = 14\text{lbs.}$

Blue— $\frac{96 \times 38 \times 110}{840 \times 24} = 19{\cdot}9\text{lbs.}$

Blue— $\frac{4 \times 38 \times 110 \times 2\text{-fold}}{840 \times 80} = {\cdot}49\text{lbs.}$

Sky— $\frac{16 \times 38 \times 110}{840 \times 24} = 3{\cdot}3\text{lbs.}$

Weft— $\frac{31 \times 68 \times 100}{840 \times 16} = 17{\cdot}2\text{lbs.}$

Weight of 3 pieces = 17·2lbs. × 3 = 51·6lbs.

COST—		Pence.
Warp, 37·2lbs., 24's at 9d. per lb.	.....	334·8
Warp, 1·49lbs., 2/80's at 1/6 ,,	....	26·8
Weft, 51·6lbs.. 16's at 7d. ,,	....	361·2
Dyeing Blue 20·3lbs. at 3½d. ,,	.....	71·
,, Sky 3·3lbs. at 2d. ,,	.....	6·6
,, Red 1lb. at 5d. ,,	.....	5·
Bleaching 14lbs. at ¾d. ,,	.....	10·5
Sizing warp, 38·6lbs. at ½d. ,,	.....	19·3
Preparing warp, 951 hanks at 1d. per 20 hanks		47·
Winding of weft, 825 hanks at 1d. per 20 hanks		41·
Weaving and expenses, 4d. per ¼ pick for 100 yards, for 3 pieces	.....	204·
		1127·2

Cost per yard— $\frac{1127}{300} = 3{\cdot}75$ pence.

CHAPTER VI.

WAGES—UNIFORM LIST.

(1) The Standard.

The standard upon which this list is based is an ordinarily-made loom, 45 inches in the reed space, measured from the fork grate on one side to the back board on the other, weaving cloth as follows :—

Width—39, 40, or 41 inches.

Reed—60 reed, 2 ends in one dent, or 60 ends per inch.

Picks—15 picks per quarter inch, as ascertained by arithmetical calculation, with $1\frac{1}{2}$ per cent. added for contraction.

Length—100 yards of 36 inches measured on the counter. Any length of lap other than 36 inches to be paid in proportion.

Twist—28's or any finer numbers.

Weft—31's to 100's, both inclusive.

Price—30d, or 2d per pick.

(2) Width of Loom.

A 45-in. reed space loom being taken as the standard, $1\frac{1}{2}$ per cent. shall be added for each inch up to and including 51 inches; 2 per cent. from 51 to 56 inches; $2\frac{1}{2}$ per cent. from 56 to 64 inches; and 3 per cent. from 64 to 72 inches. $1\frac{1}{4}$ per cent. shall be deducted for each inch from 45 to 37 inches inclusive; and 1 per cent. from 37 to 24 inches, below which no further deduction shall be made. For any fraction of an inch up to the half no addition or deduction shall be made, but if over the half the same shall be paid as if it were a full inch. All additions or deductions under this clause to be added to or taken from the price of the standard loom, 45 inches.

Deducted from Standard.				Added to Standard.			
Loom.	Per Cent.	Loom.	Per Cent.	Loom.	Per Cent.	Loom.	Per Cent.
Inches.		Inches.		Inches.		Inches.	
24	23	35	12	46	1½	60	29
25	22	36	11	47	3	61	31½
26	21	37	10	48	4½	62	34
27	20	38	8¾	49	6	63	36½
28	19	39	7½	50	7½	64	39
29	18	40	6¼	51	9	65	42
30	17	41	5	52	11	66	45
31	16	42	3¾	53	13	67	48
32	15	43	2½	54	15	68	51
33	14	44	1¼	55	17	69	54
34	13	45	Standard.	56	19	70	57
				57	21½	71	60
				58	24	72	63
				59	26½		

(3) Broader Cloth than Admitted by Clause 2.

All looms shall be allowed to weave within 4 inches of the reed space, but whenever the difference between the width of cloth and the reed space is less than 4 inches, it shall be paid as if the loom were 1 inch broader, and if less than 3 inches, as if it were 2½ inches broader.

(4) Allowances for Cloth 7 to 15 Inches Narrower than the Reed Space.

When the cloth is from 7 to 15 inches inclusive narrower than the reed space of the loom in which it is being woven, a deduction in accordance with the following tables shall be made. No further deduction shall be made when cloth is more than 15 inches narrower than the reed space, or when cloth is narrower than 18 inches. Fractions of an inch are not to be recognised under this clause.

For Example.—A 32¼ inch cloth should be reckoned as 33, 40¼ as 41, and so on with all other widths.

Cloth.	72-in Loom.	Cloth.	69-in. Loom.	Cloth.	66-in. Loom.	Cloth.	63-in. Loom.
In.	Per cent.	In.	Per cent.	In.	Per cent.	In.	Per cent.
65	1·38	62	1·46	59	1·55	56	1·37
64	2·76	61	2·92	58	3·1	55	2·75
63	4·14	60	4·38	57	4.4	54	4·12
62	5·52	59	5·84	56	5·69	53	5·49
61	6·9	58	7·31	55	6·98	52	6·87
60	8 28	57	8·52	54	8·28	51	8·24
59	9·66	56	9·74	53	9·57	50	9·62
58	11·04	55	10·96	52	10·86	49	10·71
57	12.19	54	12·18	51	12·16	48	11·81

Cloth.	71-in. Loom.	Cloth.	68 in. Loom.	Cloth.	65-in. Loom.	Cloth.	62-in. Loom.
In.	Per cent.	In.	Per cent.	In.	Per cent.	In.	Per cent.
64	1·41	61	1·49	58	1·58	55	1·4
63	2·81	60	2·98	57	2·91	54	2·8
62	4·22	59	4·47	56	4·23	53	4·2
61	5·62	58	5·96	55	5·55	52	5·6
60	7·03	57	7·2	54	6·87	51	7·
59	8·44	56	8·44	53	8·19	50	8·4
58	9·84	55	9·69	52	9·51	49	9·51
57	11·02	54	10·93	51	10·83	48	10·63
56	12·19	53	12·17	50	12·15	47	11·75

Cloth.	70-in. Loom.	Cloth.	67-in. Loom.	Cloth.	64-in Loom.	Cloth.	61-in. Loom.
In.	Per cent.	In.	Per cent.	In.	Per cent.	In.	Per cent.
63	1·43	60	1·52	57	1·35	54	1·43
62	2·87	59	3·04	56	2·7	53	2·85
61	4·3	58	4·56	55	4·05	52	4·28
60	5·73	57	5·83	54	5·4	51	5·7
59	7·17	56	7·09	53	6·74	50	7·13
58	8·6	55	8·36	52	8·09	49	8·27
57	9·79	54	9·63	51	9·44	48	9·41
56	10·99	53	10·9	50	10·79	47	10.55
55	12·18	52	12·16	49	11·87	46	11·69

Cloth.	60-in. Loom.	Cloth.	57-in. Loom.	Cloth.	54-in. Loom.	Cloth.	51-in. Loom.
In.	Per cent.	In.	Per cent.	In.	Per cent.	In.	Per cent.
53	1·45	50	1·54	47	1·3	44	1·03
52	2·91	49	2·78	46	2·61	43	2·06
51	4·36	48	4·01	45	3·91	42	3·1
50	5·81	47	5·25	44	4·89	41	4·13
49	6·98	46	6·48	43	5·87	40	5·16
48	8·14	45	7·72	42	6·85	39	6·19
47	9·3	44	8·64	41	7·83	38	7·05
46	10·47	43	9·57	40	8·8	37	7·91
45	11·63	42	10·49	39	9·78	36	8·77

Cloth.	59-in. Loom.	Cloth.	56-in. Loom.	Cloth.	53-in. Loom.	Cloth.	50-in. Loom.
In.	Per cent.	In.	Per cent.	In.	Per cent.	In.	Per cent.
52	1·48	49	1·26	46	1·33	43	1·05
51	2·96	48	2·52	45	2·65	42	2·09
50	4·45	47	3·78	44	3·65	41	3·14
49	5·63	46	5·04	43	4·65	40	4·19
48	6·82	45	6·3	42	5·64	39	5·23
47	8·	44	7·25	41	6·64	38	6·1
46	9·19	43	8·19	40	7·63	37	6·98
45	10·38	42	9·14	39	8·63	36	7·85
44	11·26	41	10·08	38	9·42	35	8·72

Cloth.	58-in. Loom.	Cloth.	55-in. Loom.	Cloth.	52-in. Loom.	Cloth.	49-in. Loom.
In.	Per cent.	In.	Per cent.	In.	Per cent.	In.	Per cent.
51	1·51	48	1·28	45	1·35	42	1·06
50	3·02	47	2·56	44	2·36	41	2·12
49	4·23	46	3·85	43	3·38	40	3·18
48	5·44	45	5·13	42	4·39	39	4·25
47	6·65	44	6·09	41	5·41	38	5·13
46	7·86	43	7·05	40	6·42	37	6·01
45	9·07	42	8·01	39	7·43	36	6·9
44	9·98	41	8·97	38	8·28	35	7·78
43	10·89	40	9·94	37	9·12	34	8·67

Cloth.	48-in. Loom.	Cloth.	45-in. Loom.	Cloth.	42-in. Loom.	Cloth.	39-in. Loom.
In.	Per cent.	In.	Per cent.	In.	Per cent.	In.	Per cent.
41	1·08	38	·94	35	·97	32	1·01
40	2·15	37	1·87	34	1·95	31	2·03
39	3·23	36	2·81	33	2·92	30	2·84
38	4·13	35	3·75	32	3·9	29	3·65
37	5·02	34	4·69	31	4·87	28	4·46
36	5·92	33	5·62	30	5·65	27	5·27
35	6·82	32	6·56	29	6·43	26	6·08
34	7·72	31	7·5	28	7·21	25	6·89
33	8·61	30	8·25	27	7·99	24	7·7

Cloth.	47-in. Loom.	Cloth.	44-in. Loom.	Cloth.	41-in. Loom.	Cloth.	38-in. Loom.
In.	Per cent.	In.	Per cent.	In.	Per cent.	In.	Per cent.
40	1·09	37	·95	34	·99	31	1·03
39	2·18	36	1·9	33	1·97	30	1·85
38	3·09	35	2·85	32	2·96	29	2·67
37	4·	34	3·80	31	3·95	28	3·49
36	4·91	33	4·75	30	4·74	27	4·32
35	5·83	32	5·70	29	5·52	26	5·14
34	6·74	31	6·65	28	6·32	25	5·96
33	7·65	30	7·41	27	7·11	24	6·78
32	8·56	29	8·16	26	7·89	23	7·60

Cloth.	46-in. Loom.	Cloth.	43-in. Loom.	Cloth.	40-in. Loom.	Cloth.	37-in. Loom.
In.	Per cent.	In.	Per cent.	In.	Per cent.	In.	Per cent.
39	1·11	36	·96	33	1·	30	·83
38	2·03	35	1·92	32	2·	29	1·67
37	2·96	34	2·88	31	3·	28	2·5
36	3·88	33	3·85	30	3·8	27	3·33
35	4·8	32	4·81	29	4·6	26	4·17
34	5·73	31	5·77	28	5·4	25	5·
33	6·65	30	6·54	27	6·2	24	5·83
32	7·57	29	7·31	26	7·	23	6·67
31	8·5	28	8·08	25	7·8	22	7·5

Cloth.	36-in. Loom.
In.	Per cent.
29	·84
28	1·69
27	2·53
26	3·37
25	4·21
24	5·06
23	5·9
22	6·74
21	7·58

Cloth.	35-in. Loom.
In.	Per cent.
28	·85
27	1·7
26	2·56
25	3·41
24	4·26
23	5·11
22	5·97
21	6·82
20	7·67

Cloth.	34-in. Loom.
In.	Per cent.
27	·86
26	1·72
25	2·59
24	3·45
23	4·31
22	5·17
21	6·03
20	6·9
19	7·76

Cloth.	33-in. Loom.
In.	Per cent.
26	·87
25	1·74
24	2·62
23	3·49
22	4·36
21	5·23
20	6·1
19	6·98
18	7·85

Cloth.	32-in. Loom.
In.	Per cent.
25	·88
24	1·76
23	2·65
22	3·53
21	4·41
20	5·29
19	6·18
18	7·06

Cloth.	31-in. Loom.
In.	Per cent.
24	·89
23	1·79
22	2·68
21	3·57
20	4·46
19	5·36
18	6·25

Cloth.	30-in. Loom.
In.	Per cent.
23	·9
22	1·81
21	2·71
20	3·61
19	4·52
18	5·42

Cloth.	29-in. Loom.
In.	Per cent.
22	·91
21	1·83
20	2·74
19	3·66
18	4·57

Cloth.	28-in. Loom.
In	Per cent.
21	·93
20	1·85
19	2·78
18	3·7

Cloth.	27-in. Loom.
In.	Per cent.
20	·94
19	1·87
18	2·81

Cloth.	26-in. Loom.
In.	Per cent.
19	·95
18	1·9

Cloth.	25-in. Loom.
In.	Per cent.
18	·96

(5) Reeds.

A 60 reed being taken as the standard, $\frac{3}{4}$ per cent. shall be deducted for every two ends or counts of reed from 60 to 50, but no deduction shall be made below 50. $\frac{3}{4}$ per cent. shall be added for every two ends or counts

of reed from 61 to 68; 1 per cent. from 68 to 100; $1\frac{1}{3}$ per cent. from 100 to 110; and 2 per cent from 110 to 132. All additions or deductions under this clause to be added to or taken from the price of the Standard, 60 reed.

Deducted from Standard.		Added to Standard.			
Count of Reed.	Per Centage.	Count of Reed.	Per Centage.	Count of Reed.	Per Centage.
50	$3\frac{3}{4}$	62	$\frac{3}{4}$	98	18
52	3	64	$1\frac{1}{2}$	100	19
54	$2\frac{1}{4}$	66	$2\frac{1}{4}$	102	$20\frac{1}{2}$
56	$1\frac{1}{2}$	68	3	104	22
58	$\frac{3}{4}$	70	4	106	$23\frac{1}{2}$
60	Standard	72	5	108	25
		74	6	110	$26\frac{1}{2}$
		76	7	112	$28\frac{1}{2}$
		78	8	114	$30\frac{1}{2}$
		80	9	116	$32\frac{1}{2}$
		82	10	118	$34\frac{1}{2}$
		84	11	120	$36\frac{1}{2}$
		86	12	122	$38\frac{1}{2}$
		88	13	124	$40\frac{1}{2}$
		90	14	126	$42\frac{1}{2}$
		92	15	128	$44\frac{1}{2}$
		94	16	130	$46\frac{1}{2}$
		96	17	132	$48\frac{1}{2}$

(6) Cloths Woven with One End in a Dent.

Cloths woven with one end in a dent to be paid three quarters of the reed—thus a 80 reed one end in a dent would be paid for as a 60 reed.

(7) Picks.

Low—An addition of 1 per cent. shall be made for each pick or fraction of a pick below 11, thus :—

Below 11 down to and including 10, 1 per cent.
„ 10 „ „ 9, 2 „
„ 9 „ „ 8, 3 „
„ 8 „ „ 7, 4 „

and so on, adding 1 per cent. for each pick or fraction thereof.

High—An addition of 1 per cent. per pick shall be made whenever they exceed the following, if using

Weft below 26's when picks exceed 16
„ 26's to 39's inclusive „ 18
„ 40's and above „ 20

In making additions for high picks any fraction of a pick less than the half shall not have any allowance ; exactly the half shall have ½ per cent. added ; any fraction over the half shall have the full 1 per cent. added.

(8) Twist.

The Standard being 28's, or finer, the following additions shall be made when coarser twist is woven in the following reeds :—

Below 28's to 20's in 64 to 67 reed inclusive, 1 per cent.
68 to 71 „ „ 2 „
72 to 75 „ „ 3 „
Below 20's to 14's in 56 to 59 „ „ 1 „
60 to 63 „ „ 2 „
64 to 67 „ „ 3 „

and so on at the same rate. When twist is woven in coarser reeds no addition shall be made.

(9) Weft.

Ordinary Pin Cops—The Standard being 31's to 100's both inclusive, shall be reckoned equal. Above 100's 1 per cent. shall be added for every 10 hanks or fraction thereof. In lower numbers than 31's the following additions shall be made:—

For	30's,	add 1	per cent.
,,	29's, 28's,	,, 2	,,
,,	27's, 26's,	,, 3	,,
,,	25's, 24's,	,, 4½	,,
,,	23's, 22's,	,, 6½	,,
,,	21's, 20's,	,, 8	,,
,,	19's, 18's,	,, 10½	,,
,,	17's, 16's,	,, 13	,,
,,	15's, 14's,	,, 16	,,
,,	13's,	,, 18	,,
,,	12's,	,, 21	,,
,,	11's,	,, 25	,,
,,	10's,	,, 30	,,

Large Cops.—When weft of the following counts is spun into large cops so that there are not more than 22 in one pound, the following additions shall be made in place of the allowance provided for pin cops in preceding table.

For	29's, 28's,	add 1	per cent.
,,	27's, 26's,	,, 2	,,
,,	25's, 24's, 23's,	,, 3	,,
,,	22's, 21's, 20's,	,, 4½	,,
,,	19's, 18's,	,, 6	,,
,,	17's, 16's,	,, 8	,,
,,	15's, 14's,	,, 10	,,
,,	13's,	,, 12	,,
,,	12's,	,, 15	,,
,,	11's,	,, 19	,,

For 10's,	add 24 per cent.
,, 9's,	,, 30 ,,
,, 8's,	,, 38 ,,
,, 7's,	,, 48 ,,
,, 6's,	,, 61 ,,
,, 5's,	,, 76 ,,
,, 4's,	,, 94 ,,

(10) Four-Staved Twills.

Low Picks.—In Four-staved Twills an addition of 1 per cent. for each pick or fraction thereof below the picks mentioned in the following table shall be made when using weft as follows :—

Below 26's,	the addition shall	begin at 13.
26's to 39's inclusive	,, ,,	14.
40's and above	,, ,,	15.

High Picks—When using weft

below 26's	the addition for high picks	shall	begin at	21.
26's to 39's inclusive	,,	,,	,,	22.
40's and above	,,	,,	,,	23.

In making additions for high picks, any fraction of a pick less than the half shall not have any allowance; exactly the half shall have ½ per cent. added; any fraction over the half shall have the full 1 per cent. added.

(11) Herring-bone Twills.

For weaving cloths known as Herring-bone Twills, four staves, 5 per cent. extra on twill cloth prices shall be paid.

(12) Splits.

The following additions shall be made for splits :—

One split, uncut, add 5 per cent.

Two splits, ,, ,, $7\frac{1}{2}$,,

and so on at the same rate.

Empty dents only shall not be considered splits.

(13) Plain Dhooties.

There are two systems of paying for Dhooties. The first is :—

12	yard	Dhooties,	8	per	cent.	above	List (minimum).
11	,,	,,	9	,,		,,	
10	,,	,,	10	,,		,,	
9	,,	,,	11	,,		,,	
8	,,	,.	12	,,		,,	
7	,,	,.	13	,,		,,	
6	,,	,,	14	,,		,,	
5	,,	,,	15	,,		,,	
4	,,	,,	16	,,		,,	
$3\frac{1}{2}$	,,	,,	18	,,		,,	
3	,,	,,	$19\frac{1}{2}$	,,		,,	
$2\frac{1}{2}$	,,	,,	$21\frac{1}{2}$	,,		,,	

The second system is 10 per cent. upon all lengths without any deduction being made for width of cloth.

For each extra runner in Plain Dhooties an allowance of $2\frac{1}{2}$ per cent. shall be made, each allowance to be added separately.

(14) Coloured Edges or Borders.

Coloured Edges or Borders shall be paid 5 per cent. on plain cloth prices.

(15) Dobby Dhooties.

Sixteen flush ends or under, with Calcutta headings, to be paid 20 per cent. on List.

Sixteen ends and under, with Madras headings, to be paid 30 per cent. on List.

All other Dobby Borders to be paid 30 per cent., with prices for headings as per published List (see Illustrated Coloured List, agreed upon March 15th, 1886).

Dobby Dhooty or Dhooties with a plain stripe weave to be paid as per Stripe List, with percentage for Dobby Dhooty or Dhooties extra.

(16) Dhooty Headings—Extras for 40ss Yards.

That the List price of Madras headings be ¼d. for 12, ½d. for 14 headings, if woven in looms over 39 inches wide, and 1d. for 16 to 20 marks; 1½d. for 21 to 30, woven in any loom.

Large Sarrie heading, with 1 shuttle 15 bars, to be paid 1d. extra. Small Sarrie heading, with 1 shuttle 9 bars, to be paid ½d. extra.

Madras Sarrie heading, with 2 shuttles, 11 bars, including cord, to be paid ½d. extra.

Small Sarrie and Calcutta headings put in as one heading, viz.:—

4	and	4	together	to be paid	½d.
5	,,	5	,,	,,	¾d.
6	,,	6	,,	,,	1d.
7	,,	7			
8	,,	8	,,	,,	1½d.
10	,,	10			

in the nearest multiple to 40 yards.

Bombay chocolate heading, with 2 shuttles 14 bars, to be paid 1d. extra for 16 marks.

Madras chocolate heading, with 4 shuttles 18 bars, including cord, to be paid 1d. per cut extra for 8, 1¼d. for 10, 1½d. for 12, 1¾d. for 14, and 2d. for 16.

Red Madras heading, with 2 shuttles 10 bars, including cord, to be paid ¼d. for 12 headings, and ½d. for 14, if woven in looms over 39 inches wide, and 1d. for 16 to 20 marks, and 1½d. for 21 to 30, in any loom.

What is known as 9-bar Bombay heading, with 1 shuttle 11 bars, to be paid 1d. extra for 16 marks.

Bombay chocolate heading, with 3 shuttles 14 bars, to be paid 1d. extra for 16 marks.

Ordinary Calcutta heading, with 5 bars, no extras.

Bombay heading, with 4 bars, 16 ends and under, 20 per cent., with extras for headings as per Madras headings: ¼d. for 12, ½d. for 14, 1d. for 16 headings in the nearest multiple to 40 yards.

Bombay heading, with 5 bars, 16 ends and under, 20 per cent., with extras for headings as per Madras headings: ¼d. for 12, ½d. for 14, 1d. for 16 headings in the nearest multiple to 40 yards.

Bombay heading, with 4 bars and 2 bars, 16 ends and under, 30 per cent., with extras for headings as per Madras heading: ¼d. for 12, ½d. for 14, 1d. for 16 headings in the nearest multiple to 40 yards.

Bombay headings with 5 bars and 2 bars, 16 ends and under, 30 per cent., with extras for headings as per Madras

headings: ¼d. for 12, ½d. for 14, 1d. for 16 headings in the nearest multiple to 40 yards.

Bombay, heading, with 9 bars and 2 bars, 16 ends and under, 30 per cent., with extras for headings as per Madras headings: ¼d. for 12, ½d. for 14, 1d. for 16 headings in the nearest multiple to 40 yards.

Bombay heading, with 9 bars and 2 bars, 16 ends and under, 30 per cent., with extras for headings as per Madras headings: ¼d. for 12, ½d. for 14, 1d. for 16 headings in the nearest multiple to 40 yards.

Borders over 16 ends 30 per cent., with the above extras for headings.

(17) Extra Runner in Dobby Dhooties.

For each extra runner in Dobby Dhooties an allowance of 5 per cent. shall be made, such allowance to be added separately.

(18) One-sided Dobby or Apron Cloths.

One-sided Dobby or Apron Cloths, with 16 flush ends and under, to have 10 per cent. on plain cloth prices; over 16 flush ends to have 20 per cent. on plain cloth prices; Dobby Leno Sides 2½ per cent. extra.

(19) Combined Coloured and Grey Stripes in Dhooty Cloths.

Combined Coloured and Grey Stripes in which the grey yarn is crammed, or requires two beams to form a stripe, 10 per cent. in addition to the Dhooty price shall be paid.

Coloured Stripes with not more than two dents of grey yarn crammed at each side of the coloured stripe, to be paid 5 per cent. in addition to the Dhooty price; extra ends, to make the coloured or grey stripe, to be counted in ascertaining the reed. When the grey yarn crammed exceeds two dents, 10 per cent. extra shall be paid.

(20) Rep Headings in Plain and Dobby Dhooties.

Basis--Plain Cloth as per Uniform List.

For 16 headings, 1½d. per cut to be added. Any other number of headings to be paid in proportion, together with one-tenth of a penny per change on all changes above 10 in each half heading.

Every required stoppage of loom for putting in of headings, to be counted as a change.

All headings containing up to 200 picks inclusive, that is picks "Repped," to be paid one halfpenny per cut extra; 201 to 400 picks, three farthings per cut extra; over 400, a farthing for each 100 or fraction thereof.

The above percentages to be paid on nett price. All lost picks to be counted, and included in calculations.

Plain Dhooties—For Borders, 5 per cent. extra to be added to plain cloth price.

Dobby Dhooties—Dobby Borders, with 16 flush ends or under, 15 per cent. to be added on plain cloth price; all other Dobby Borders, 25 per cent.

(21) Grey Dhooty Headings.

Over and above the Ten per cent. or Scale Payment.

(See Clause 13.)

7 to 9 Goal Headings.

Headings put in by Hand.	Headings put in by a Motion.
¼d. for 12 headings.	$\frac{3}{16}$d. for 12 headings.
½d. for 14 ,,	⅜d. for 14 ,,
1d. for 16 to 20 ,,	¾d. for 16 to 20 ,,

11 to 15 Goal Headings.

Headings put in by Hand.	Headings put in by a Motion.
⅔d. for 12 headings.	¼d. for 12 headings.
¾d. for 14 ,,	½d. for 14 ,,
1½d. for 16 to 20 ,,	1d. for 16 to 20 ,,

to be reckoned to the nearest multiple in 40 yards.

(22) Tape-Bordered Cloth without Pattern.

Tape-bordered Cloth without pattern, over ¼ of an inch in width up to ¾ of an inch, shall have 2½ per cent. added to plain cloth price together with extra ends in reeds.

(23) Plain Grey Shawl Headings.

Plain Grey Shawl Headings, one goal, to have 3 per cent. over plain cloth prices.

(24) Sateens, Jeans, Jeanettes, Drills, Drillettes and Florentines.

Basis—Plain Cloth as per Uniform List, with the following modifications.

Reeds—When cloths are woven with three or more ends to one dent, the allowance for every two ends or counts of reeds above 68 shall be ¾ per cent. only, the same as from 60 to 68. When the reed exceeds the pick, ¾ per cent. shall be added for every additional count of reed above the number of picks per ¼ inch.

Picks—Cloths up to and including 25 picks to be paid 5 per cent. extra, and for every additional pick or fraction beyond the half, up to and including 32 picks, to have ½ per cent. per pick added, from 32 picks upwards to have an additional ¼ per cent. per pick or fraction beyond the half added.

Pick Finding—Where the Employer requires the loom to be turned in order to find the broken picks, the following percentages to be paid :—

5	per cent.	when using	26's or finer weft.
7½	,,	,,	25's to 16's weft.
10	,,	,,	15's to 12's weft.
12½	,,	,,	11's or under.

Coarse Twist in Fine Reeds—Clause 8 of the Uniform List to apply, and when there are more than two ends in one dent, the reed and number of ends per inch to be added together and divided by two. Thus a 52 reed three ends in one dent below 28's to 20's twist would be paid for as a 65 reed, and when using twist below 20's to 14's in a 45 reed three ends in one dent would be paid for as a 56 reed, for twist purposes only.

(25) SATEENS MADE WITH MORE THAN 5 STAVES.

Sateens made with more than 5 staves to be paid by the Sateen List, with the following addition for staves :—

6 staves, 12 per cent.

7 and 8 staves, 16 per cent., and so on.

Paragraph 6 of the Stave List not to apply to the above.

(26) STAVE WORK.

Cloth with dobby and tappet motions, one-shuttle loom (Lenos, Sateens, Jeans, Jeanettes, Drills, Drillettes and similar goods excepted.

1. *Basis*—Plain Cloth as per Uniform List.

2. Cloth woven with the number of staves as follows :

4 staves,	12% added.			13 staves,	20% added.		
5	,,	12	,,	14	,,	22	,,
6	,,	12	,,	15	,,	23	,,
7	,,	16	,,	16	,,	24	,,
8	,,	16	,,	17	,,	25	,,
9	,,	16	,,	18	,,	26	,,
10	,,	18	,,	19	,,	27	,,
11	,,	18	,,	20	,,	28	,,
12	,,	19	,,				

3. Single-lift Dobbies to be paid 10 per cent. extra.

4. Stripes and other cloths with more than two ends in one dent to be paid for by the number of ends per inch.

5. Skelton staves for selvedges not to be counted.

6. Where the Employer does not require the card or lattice to be turned in order to find the pattern, 3 per cent. less to be paid.

7. Where the Employer requires the loom to be turned in order to find the broken picks, 10 per cent. more to be paid.

8. Plain Handkerchief, 72 reeds and below, to be paid 5 per cent. extra.

9. Single-shuttle Cord Checks, with more than two picks in one shed, to be paid $2\frac{1}{2}$ per cent. less.

10. In single-shuttle Checks, Handkerchiefs and all other special classes of goods in which more than one pick is put in one shed, such extra picks shall be counted.

11. For cloths woven in tappet or dobby looms from two beams, 5 per cent. extra shall be paid; for cloths woven in tappet or dobby looms from three beams, 10 per cent. extra shall be paid; Lenos, Loops, and Crimps excepted.

12. Any other goods of a difficult character to be paid extra, the amount of which shall be fixed upon by the Employers and Operatives' Association.

(27) Stave Work with Dobby Dhooty Borders.

Basis—Plain Cloth as per Uniform List.

Cloth woven with the number of staves as follows:—

4 to	8 staves	5 per cent.	to be	added.
9 „	8 „	„	„	
10 and 11 „	12 „	„	„	
12 to 14 „	14 „	„	„	
15 and 16 „	16 „	„	„	
17 and 18 „	18 „	„	„	

If the lattice is to be turned, 3 per cent. more to be paid.

The above extras to be added separately to the percentage allowed for flush ends and headings.

(28) Additions upon Plain Cloth Prices for Weaving Jacquards.

Basis—Uniform List with the following modifications:—Plain and satin grounds 25 per cent.; single-lift machines 35 per cent.

When cloths, satin ground, are woven with three or more ends in one dent, the allowance for every two ends or counts of reed above 68 shall be $\frac{3}{4}$ per cent. only, the same as from 60 to 68.

Picks—Uniform List up to and including 30 picks, from 30 to 40, $\frac{3}{4}$ per cent. per pick, all above 40, $\frac{1}{2}$ per cent. per pick.

Mock Lenos and Lace Brocades to be paid 5 per cent. extra.

Any other goods of a difficult character to be paid extra, the amount of which shall be fixed upon by the Employers and Operatives associations.

Pick Finding—Where the Employer requires the loom to be turned in order to find the broken picks, the following percentages to be paid :—

7½	per cent.	when	using	18's or finer weft.
10	,,	,,	,,	17's to 12's weft.
12½	,,	,,	,,	11's or under.

(29) Cotton Crimps.

Basis—Plain Cloth as per Uniform List.

Cloth woven with the number of staves as follows :—

4	staves,	20%	added.	12	staves,	28%	added.
5	,,	21	,,	13	,,	30	,,
6	,,	22	,,	14	,,	32	,,
7	,,	23	,,	15	,,	34	,,
8	,,	24	,,	16	,,	37	,,
9	,,	25	,,	17	,,	40	,,
10	,,	26	,,	18	,,	44	,,
11	,,	27	,,	19	,,	48	,,

When coloured yarn is used to form a stripe, 5 per cent. extra shail be paid.

When all the warp is coloured, the price to be paid shall be by arrangement.

(30) All Classes of Stripes and Cords in Plain Looms.

Basis—Plain Cloth as per Uniform List.

All classes of Stripes and Cords made from one beam and one count of yarn to be paid 4 per cent. and reedage, and if made from two beams 7½ per cent. and reedage, and if made from three beems 12½ per cent. and reedage.

All classes of Stripes and Cords made from two or more counts of yarn and made on one or two beams to

be paid 7½ per cent. and reedage, and if the ground work is one end in a dent, the reedage shall be found by dividing the difference between the actual reed used and the number of ends in the cloth.

(31) Coloured Stripes, etc., in Taped or Slashed Warps.

That when using up to 15 per cent. of coloured yarn in the warp, 5 per cent. extra to be paid.

Over 15 per cent. to 25 per cent. of coloured yarn in the warp, 7½ per cent. extra to be paid.

Over 25 per cent. of coloured yarn in the warp, the payment to be by the Colne Coloured List. Bleached warp or weft to be called a colour.

If all the warp is grey yarn, and using coloured or bleached weft, 5 per cent. extra to be paid.

If using coloured weft and any coloured yarn in the warp, the payment to be by the Colne Coloured List.

This arrangement does not apply to Crimps and Lenos when using over 25 per cent. of colour, or coloured Dhooties.

(32) Lenos.

One doup, 70 per cent. on Plain List.
Two doups, 80 „ „ „

Leno and Crimp cloth combined to be paid Leno price, plus 10 per cent. for Crimp; the addition for Crimp and Leno to be put on together.

(33) Saccharilla Headings.

1d. per cut extra should be paid for all Saccharilla headings, large or small.

(34) Gold Headings.

Headings which contains 50 picks of gold or more in 40 yards, be paid at the rate of ·01d. for each pick.

Example—Multiply the number of picks of gold by 40, and divide by the length of the cut. If the answer should give 50 or more, then you would pay ·01d. per pick for the number of picks put in, but should the answer be less than 50, then no extra would be paid.

22 picks of gold in 17½ yards would be paid ·22d.

40 yards——

17·5) 8800 (50 in 40 yards.
875·
5

21 picks of gold in 17½ yards would be paid no extra.

40 yards——

17·5) 8400 (48 in 40 yards.
700
1400
1400

(35) Additions and Deductions.

All the foregoing additions and deductions shall be made separately.

(36) Reduction.

The foregoing portion of this list is subject to a reduction of 7½ per cent., except in the case of additions for Rep headings. (See Clause 20.)

(37) Coloured Handkerchiefs With Automatic Stop-Motion Shuttles Changed by Hand.

For 72 Handkerchiefs or 144 Borders, one, two or three in a width, 3¼d. for changes up to four in each border, and ⅜d. per piece of 72 handkerchiefs for each change above four. If less or more than 72 handkerchiefs the 3¼d. and ⅜d. to be reduced or increased in proportion.

These additions to be made to the full Uniform List, with 2½ per cent. added.

(38) Grey Checks.

Circular-box Grey Checks to be paid by the Colne Coloured Goods List, check basis, less 15 per cent. for there being no colour.

(39) Worsted Goods.

The following are paid Net:—

Reed—Any length.

Length—100 yards of 37 inch stick or 108 yards of warp.

Twist—Any numbers up to and including 54's black, white, bleached or coloured, but 55's and finer numbers to be paid 5 per cent. extra.

Weft—40's Botany or Leicester Botany and finer number; but Lustre, Demi-Lustre, Mohair and Alpaca in any numbers; and Botany or Leicester in numbers coarser than 40's to be paid 10 per cent. extra.

Price—A 45-in. reed space loom being taken as the standard, 41·375d. to be paid for 15 picks per ¼ inch in the loom.

Width of Loom—Measured from back board to fork grate 1½ per cent. per inch to be deducted for widths below 45 inches down to 30 inches reed space, and nothing to be deducted below 30 inches.

Above	45-in.	to 51-in.,	1½	per cent.	per inch to be added
„	51-in.	„ 57-in.,	2	„	„ „
„	57-in.	„ 63-in.,	2½	„	„ „
„	63-in.	„ 69-in.,	3	„	„ „
„	69-in.	„ 75-in.,	3½	„	„ „
„	75-in.	„ 81-in.,	4	„	„ „

Narrower Cloth in Broad Looms—Cloth 17 to 15 inches narrower than the reed space of the loom in which it is woven to be paid at a rate half way between the price of the narrower loom in which it might be woven and the price of the broader loom in which it is woven.

Picks—15 to 25 picks to be calculated proportionately; below 15 picks ½ per cent. per half pick, and 1 per cent. per pick to be added, and above 25 picks ½ per cent. for every two picks or lesser part to be added.

Wool Warps—Plain Cloth woven with a single worsted or wool warp, to be paid 20 per cent. extra; Single Twill, Double Twill, Satin, Dobby, or Jacquard Cloth, woven with a single worsted or wool warp to be paid 15 per cent. extra; and any goods woven with a two-fold worsted or wool warp, to be paid 10 per cent. extra.

Dobbies—To be paid according to the Uniform Stave List.

Jacquards—Double-lift Jacquards, 25 per cent. extra; Single-lift Jacquards 35 per cent. extra; turning back

the card cylinder is included. If the weaver is required to turn the loom over to find the pick, 10 per cent. extra to be paid.

All the foregoing Lists have been duly agreed to by a Joint Committee of Employers and Operatives' representatives, at meetings held on various dates, and in each case confirmed at the following meeting.

Signed on behalf of the North and North-East Lancashire Cotton Spinners and Manufacturers' Association,

F. A. HARGREAVES, } *Joint*
JOHN TAYLOR, } *Secretaries.*

Signed on behalf of the Northern Counties Amalgamated Associations of Weavers,

W. H. WILKINSON, *Secretary.*

October, 1901.

The List is subject to a reduction of $7\frac{1}{2}$ per cent.

1903.

ADDENDA TO THE UNIFORM LIST FOR WEAVING.

At a Joint Meeting, held on February 10th, 1903, it was agreed that for weaving two Beam Jacquard Cloths, that five per cent. extra should be paid, and for weaving three Beam Jacquard Cloths ten per cent. extra should be paid. Lenos, Loops and Crimps excepted. The same to come into operation on the first pay day in April, 1903.

At the same Meeting the Committee decided that cloths woven with one or two coloured ends at the side,

came within clause 14 of the Uniform List, and should be paid 5 per cent. extra.

Signed on behalf of the Employers,

JOHN TAYLOR.

F. A. HARGREAVES.

Secretaries of the North and North-East Lancashire Cotton Spinners and Manufacturers' Association.

Signed on behalf of the Operatives,

W. H. WILKINSON.

Secretary of the Northern Counties' Amalgamated Association of Weavers.

COLNE AND DISTRICT STANDARD LIST OF PRICES FOR COLOURED GOODS.

(1) THE STANDARD.

The standard upon which the price for plain and striped goods is based is as follows:—

Cloth—28, 29, or 30 inches in width.

Reed—52 to 64, both inclusive, or 26 to 32 dents per inch, 2 ends in a dent.

Length—74 yards of warp, 36 inches to the yard.

Weft—16's or any finer counts.

Price—1½d. per pick

The standard upon which the price for checks is based is 70 yards of warp, 2d. per pick; in all other particulars the same as the standard for plain and striped goods.

(2) REEDS.

Reeds—52 to 64 inclusive, or 26 to 32 dents per inch, 2 ends in a dent, being taken as the standard.

Add—Above 64 to 70, 2 per cent.; above 70, an

additional 1 per cent. for each extra dent, or 2 ends per inch.

Deduct—Below 52 down to and including 46, 2 per cent., and below 46, 3 per cent., beyond which no further deduction shall be made.

(3) Cloth.

The standard, being 28, 29, or 30 inches, is reckoned equal.

For each inch below 28, $\frac{3}{4}$ per cent. is to be deducted down to 20 inches, beyond which no further reduction shall be made.

Above 30 inches up to and including 36, 1 per cent per inch is to be added. Above 36 to 40, $1\frac{1}{2}$ per cent., and above 40, $2\frac{1}{2}$ per cent. per inch.

(4) Undressed Warps.

Ordinary half-beer warps, dyed, sized, or bleached in the warp, to be paid extra as follows :—

All one colour, - - -	·035	per yard.
Two colours, white or grey counted,	·045	„
Three „ „ „	·055	„
Four „ „ „	·075	„

increasing ·02 per yard for each additional colour, selvages not reckoned a colour. Warps wound on so as to avoid crossing or splitting of half-beers in weaving, to be paid ·035 per yard.

(5) Half-Dressed Warps.

All warps run through a reed, but neither dressed nor brushed by hand, and when broken threads are not found and pieced in the usual way, shall be considered half-dressed warps, and paid as follows :—

All one colour, - - -	·02	per yard.
Two colours, white or grey counted,	·03	„
Three „ „ „	·04	„
Four „ „ „	·05	„

(6) Coarse Twist in a Fine Reed.

Below 16's in a 68 or finer reed (2 threads in a dent), 2 per cent. per count to be added. 14's 2-fold yarn, that is 2/28s, to be paid as 16's, and so on in proportion.

(7) Weft.

No addition or deduction to be made for weft finer than 15's.

15's	add	2	per cent.
14's	,,	4	,,
13's	,,	6	,,
12's	,,	8	,,
11's	,,	11	,,
10's	,,	14	,,
9's	,,	18	,,
8's	,,	22	,,

Hank Weft.—Hank weft woven into plain or striped goods from tubes or bobbins shall be paid 5 per cent. extra.

(8) Shaft Work with Dobbies.

No extra payment shall be made for cloths woven with 6 or any less number of lifts or treads that can be worked with tappets although dobbies are used.

All cloths woven with dobbies that cannot be worked with tappets to be paid extra as follows:—

Up to and including 10 lifts or treads add 10 per cent.
11 to 14 lifts or treads inclusive ,, 14 ,,
15 to 18 ,, ,, ,, ,, 18 ,,
increasing 1½ pe cent. for each additional lift or tread.

(9) Pick Finding in Looms without Dobbies.

Whenever the employer requires the weaver, in cloth with 3 or more lifts or treads, to turn the loom backward

or forward in order to find the shed in which the weft broke, he shall pay an advance of 10 per cent.

(10) Additions and Deductions.

All the above additions and deductions shall be made separately.

(11) General.

This list shall come into force after the first making up day in September next for new classes of cloth, and for all classes of cloth to which it applies on the first making up day in November. If any dispute should arise as to the interpretation of any of the previous conditions or clauses, or as to the price to be paid for weaving any goods, a meeting of the two Committees (Employers and Employed) shall be held with a view to an amicable settlement thereof before any strike takes place.

The foregoing list was unanimously adopted at a joint meeting of Committees representing Employers and Operatives, held at the Crown Hotel, Colne, on Thursday, the 26th day of June, 1890, and finally settled between the two Secretaries at a conference held on July 16th, 1890.

Signed on behalf of the Employers,

Joshua Rawlinson,
Secretary of the Colne and District Coloured Goods Manufacturers' Association.

Signed on behalf of the Operative Weavers,

T. Birtwistle,
Secretary of the North-East Lancashire Weavers' Association.

Addenda.

(12) Three or more Threads in One Dent,

When the number of lifts used are equal to the

number of threads in a dent, the reed to be paid for shall be found as follows :—

For 3 threads in one de	t	add	25 per cent.
„ 4	„	„	50 „
„ 5	„	,	75 „
„ 6	„	„	100 „

to the actual reed used, Stockport counts, 2 ends in one dent.

Example—A 40 reed, or 20 dents per inch, 3 in each dent, shall be paid for as 50.

40 reed, 4 in a dent, as 60
40 „ 5 „ 70 reed, and so on.

When the number of lifts used are not equal to the number of threads in each dent, the reed to be paid for shall be found as follows :—

For 3 ends in one dent		add	$37\frac{1}{2}$	per cent.
„ 4	„	„	75	„
„ 5	„	„	$112\frac{1}{2}$	„
„ 6	„	„	150	„

to the actual reed used, Stockport counts, 2 ends in one dent.

Example—A 40 reed (20 dents per inch), 3 ends in each dent, as a 55.

The same reed with 4 in a dent as 70
„ „ 5 „ 85
„ „ 6 „ 100 reed, and so on, provided always that in no case shall a lower reed than 52 be paid for.

(13) One Thread in a Dent.

One thread in a dent shall be paid for as if the reed were half way between the actual number of threads per

inch, and what it would be if there were 2 threads in a dent.

Example—What is known as 80 reed, 40 dents per inch, 1 thread in a dent, would be paid for as a 60 reed.

(14) MEXICANS.

Mexicans shall be paid by this list without any addition or deduction.

The foregoing addenda has been agreed to between the Committees representing the Employers and Operatives, and the wording finally settled between the two Secretaries and Mr. Richard Riley, at a conference held on the 15th day of September, 1891.

Signed on behalf of the Employers,

JOSHUA RAWLINSON,
Secretary of the Colne and District Coloured Goods Manufcturers' Association.

Signed on behalf of the Operative Weavers,

T. BIRTWISTLE,
Secretary of the North-East Lancashire Weavers' Association.

Addenda to Colne Coloured Goods List.

COLOURED LENOS.

One Doup, 2 or more Fold Yarn only.

Up to 150	ends	.....	40%
151 to 200	,,	.....	50%
201 to 250	,,	.....	55%
251 to 300	,,	.....	60%
301 to 350	,,	.....	65%
351 to 400	,,	and over	70%

Rising 10% for each extra Doup.

Pick Finding and extra beams included.

If Dobby is used for making a figure, Clause 8 of Colne Coloured List to apply.

Whenever plain stripes are woven in check looms, the Employer shall change the box and speed the loom.

To come into operation on June 3rd, 1903, and to be paid for the first time on the second pay day in June, 1903.

Signed on behalf of the Employers,

JOHN TAYLOR,

F. A. HARGREAVES,

Secretaries of the North and North-East Lancashire Cotton Spinners and Manufacturers' Association.

Signed on behalf of the Operatives,

WM. H. WILKINSON,

Secretary of the Northern Counties' Amalgamated Association of Weavers.

May 26th, 1903.

WORKING THE LIST.

In working out the weaving price, the items are taken in the order they occur in the cloth, namely :—

Reed space of loom.
Width of cloth.
Length.
Reed.
Pick.
Twist.
Weft.

Example—What is the price paid for weaving a piece of cloth made to the following particulars:—Woven in a 36-inch reed space loom, 32 inches width, 125 yards long stick length, 70 reed, 17·9 picks per quarter inch, 32's twist, 50's weft, plain cloth?

2d.	price per pick.
·22	11 per cent. off for width of loom.
1·78	
126½	yards of 36 inches length.
1068	
356	
178	
89	
Divided by 100=2·2517	
·0900	4 per cent. on for reed.
2·3417	
17·9	picks per quarter inch.
210753	
163919	
23417	
41·91643	
3·14373	7½ per cent. off list.*
38 77270	

Price, 3/2¾d.

Find the list price paid for weaving a sateen cloth woven in a 42-inch reed space loom, the cloth made to the following particulars:—32 inches width, 116 yards

*1903—The list at present is paid less 7½ per cent. off.

long stick length, 64 reed 3 ends in a dent (which equals a 96 reed 2 ends in a dent), 28 picks per quarter inch, 50's twist, 40's weft.

	2d.	price per pick.
	·075	$3\frac{3}{4}$ per cent. off for width of loom.
	1·925	
	·075	3·9 per cent. off for narrow cloth.
	1·850	
	$117\frac{1}{2}$	yards of 36 inches length.
	12950	
	1850	
	1850	
	925	
Divided by 100 =	2·17375	
	·29345	$13\frac{1}{2}$ per cent. on for reed.
	2·46720	
	28	picks per quarter inch.
	197376	
	49344	
	69·0816	
	3·4540	5 per cent. on for 25 picks.
	72·5356	
	1·0880	$1\frac{1}{2}$ per cent. on for picks exceeding 25.
	73·6236	
	5·5217	$7\frac{1}{2}$ per cent. off list.
	68·1019	
Price, 5/8.		

The items can be taken in any order, but there is less danger of any of the additions or deductions being overlooked if taken in the order named.

Colne Coloured List.

Find the price paid for weaving a cloth 36 inches wide, 110 yards of warp long, 36 inches to the yard 70 reed, 18 picks per quarter inch, 36 warp, and 50's weft plain striped cloth.

1·5d. price per pick.
·09 6 per cent on for width of cloth.

1·59
110 yards length.

1590
159

174·94 ÷ 74 = 2·363
158 ·047 2 per cent. on for reed.

269 2·410
222 18 picks.

470 1928
444 241

260 43·38 price for 110 yards.
222

38 Price, 3s. 7½d.

BLACKBURN OVERLOOKERS' POUNDAGE.

	s.	d.	s.	d.
Ordinary Shirtings	1	4 to	1	5
Jacconets	1	4 to	1	5
Twills	1	4 to	1	7
Staved Work	1	6 to	1	8
Dhooties	1	4 to	1	6
Dobbies	1	5 to	1	10

BURNLEY OVERLOOKERS' POUNDAGE.

NET PRICES.

	s.	d.	s.	d.
Plain Cloths	1	1 to	1	3
Twills	1	3 to	1	5
Jeanettes	1	3 to	1	5
Dobbies	1	4½ to	1	9
Splits	1	2 to	1	9
Dhooties	1	3		
Drills	1	3½		

Overlookers' poundage is not subject to any reduc- it having been previously deducted from the weavers' wages.

BURNLEY LIST OF PRICES FOR BEAMING AND WINDING.

Net.

BEAMING.

For beaming 400 ends, 17,500 yards, 5 wraps, the payment to be as follows:—

4d. per beam for creeling, and 4d. for each wrap, irrespective of counts of twist.

For every 10 ends, or fraction thereof, one halfpenny, up or down, but no deduction below 370 ends, thus :—

For 400 ends, 5 wraps, 17,500 yards, the price will be 2s. per beam, including creeling.

For 441 to 450 ends, the price will be 2s. 2½d. per beam, including creeling.

For 379 ends and below, the price will be 1s. 10½d. per beam, including creeling.

The operative will be required to turn the beam backward to find broken ends.

The beamers' wages to rise and fall along with weavers' wages.

Winding.

For winding 60lbs. of Twist :—

	s.	d.
16's to 18's Twist	1	3
20's to 22's ,, ...	1	4½
24's to 26's ,, ...	1	5¾
28's to 30's ,, ...	1	6¾
32's to 34's ,, ...	1	8
36's to 38's ,, ...	1	9½
40's to 42's ,, ...	1	11
44's to 48's ,, ...	2	0½
50's to 52's ,, ...	2	2
54's to 58's ,, ...	2	3½
60's to 62's ,, ...	2	5

Intermediate counts not named above in proportion.

The winders' wages to rise and fall along with weavers' wages.

Signed on behalf of the Burnley Master Cotton Spinners and Manufacturers' Association,

F. A. HARGRAVES, *Secretary.*

Signed on behalf of the Burnley Weavers, Winders and Beamers' Association,

FRED THOMAS, *Secretary.*

Burnley, Oct. 1901.

TELEGRAPHIC ADDRESS: "PLATTS, OLDHAM."

PLATT BROTHERS & Co., Ltd.,

Hartford Iron Works, OLDHAM, England,

Makers of Machinery in great variety, for OPENING, CARDING, COMBING, PREPARING, SPINNING, DOUBLING, and WEAVING Cotton, Wool, Worsted, Silk Waste, Asbestos, &c.; also GINS for long or short-stapled Cottons, including:—

Macarthy and other patterns of Roller Gins.

Hopper Bale Breaker or Improved Cotton Pulling Machine working in combination with Hopper Feeding Machine, **Crighton Opener Cylinder Part and Exhaust Opener and Lap Machine.**

Waste Opening and Feeding Machine, to work in connection with Exhaust Opener and Lap Machine.

Improved Self-Acting Willow.

Scutchers with all latest improvements.

Patent Revolving Self-Stripping Flat Carding Engines of various sections, 72 Flats 2″ wide, 90 Flats $1\frac{5}{8}$″ wide, and 106 Flats $1\frac{3}{8}$″ wide.

Patent Grinding Machines.

Sliver Lap and Ribbon Lap Machines for Heilmann's Cotton Comber.

Patent Combing Machines for Cotton (Heilmann's system). 6, 8, or 10 boxes, 8″, $10\frac{1}{2}$″, 11″, or 12 laps.

Drawing, Slubbing, Intermediate, and Roving Frames for Cotton, Worsted, &c. Single or Duplex Cones.

Patent Self-Acting Mules for coarse, medium, and fine Yarns.

Ring and Flyer Spinning and Doubling Machines for all kinds of material. Patent Reels and Bundling Presses.

Looms and Preparation Machinery for all descriptions of Plain and Fancy Cloths.

Improved Machinery for Waste, Vigogne, and Barchant Yarns. Hard Waste Machinery.

Improved Machinery for Carding, Combing, Preparing, and Spinning Worsted on both the French and English or Bradford systems (with Cone Intermediate and Roving, if required).

Woollen Machinery. Tape and other systems of Condensers. Browns & Beran's Patent Carding Engines for Wool, and Fairgrieve & Mercer's Patent Rubbing Arrangement for Single or Double Doffer Condensers.

Patent Machinery for working short Silk Waste.

Machinery for Working ASBESTOS. Patent Brick-Making Machinery.

Highest Awards of Merit at all Exhibitions for Textile Machinery, including "Grand Prix and Gold Medal," Paris, 1900.

Butterworth & Dickinson, Ltd.

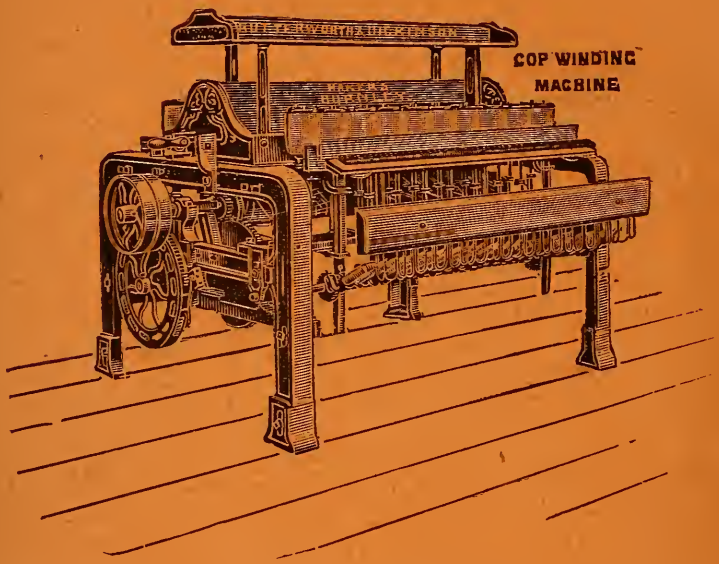
GLOBE & SAUNDER BANK IRON WORKS,

BURNLEY.

MAKERS OF ALL DESCRIPTIONS OF

Looms and Preparing Machinery

FOR COTTON, LINEN, AND WORSTED GOODS.



Cop, Pirn, and Drum Winding Machines.

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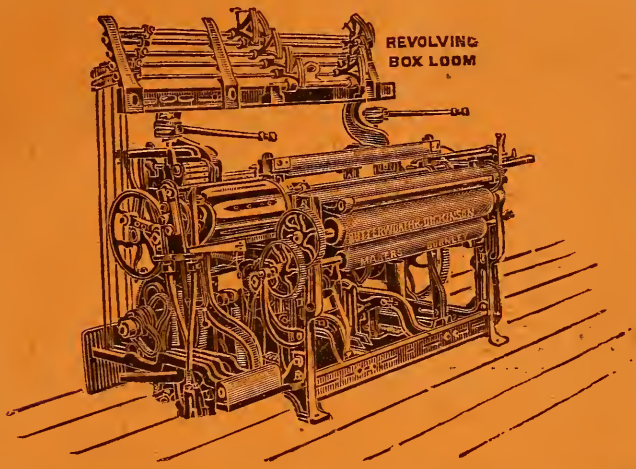

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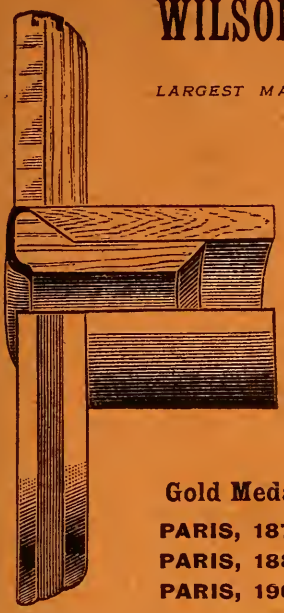

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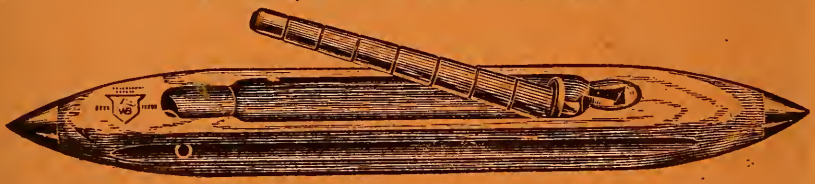

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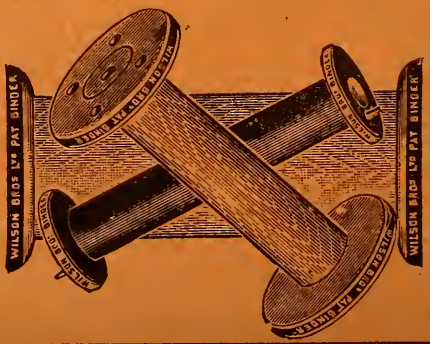

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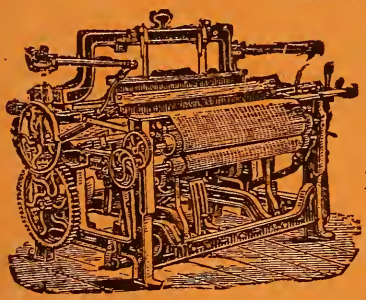

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